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The Panama-Pacific Exposition

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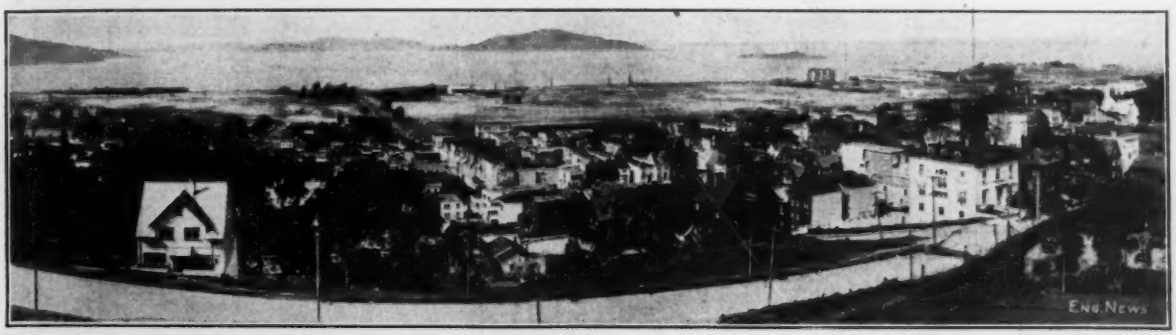
SYNOPSIS—The Panama-Pacific International Exposition of 1915, at San Francisco, Calif., promises to rank high among modern expositions in regard to its architectural, engineering and decorative features. The construction work is well advanced, and the accompanying article deals with the site, planning, decoration, and the architectural and engineering design of the buildings. Of special interest is the use of timber instead of steel for the structural framework of the great exposition buildings.

The Panama-Pacific International Exposition, which is to be held in San Francisco in 1915 to celebrate the completion of the Panama Canal, will be the first great international exposition in this country since the Louisiana Purchase Exhibition held at St. Louis in 1904. The exposition was organized in 1910 by a number of citizens of San Francisco, and at a public meeting held in April of that year over $4,000,000 was subscribed toward the expenses. The project was recognized by Congress in February, 1911, and the promoters gave assurance that they would ask no aid from the Federal Government. The State of California and the City of San Francisco have extended aid to the project.

There are many matters of technical interest regarding the exposition, both as to general planning, the building design, and the artistic treatment, as well as in such engineering features as the structural work, the water-supply and sewerage, and the mechanical and electrical equipment. In the accompanying description of the exposition, attempt has been made to present information of general interest to the engineering profession, and to deal with more than mere technical features, in order to show that the engineer engaged on work of this kind comes in close contact with matters beyond these particular features. The paper has been prepared with the sanction of the writer's superior and the Publicity Department of the exposition, and he wishes to acknowledge the valuable assistance rendered by members of the engineering and architectural staff.



View Looking toward the Bay, April 2, 1913

View Looking toward Golden Gate, September, 1913

Fig. 1. Site of the Panama-Pacific International Exposition at San Francisco

Construction Methods and Progress

To facilitate the rapidity of construction and to eliminate the necessity of purchasing plant and creating a construction organization, most of the work is being done by contract. In addition the exposition maintains

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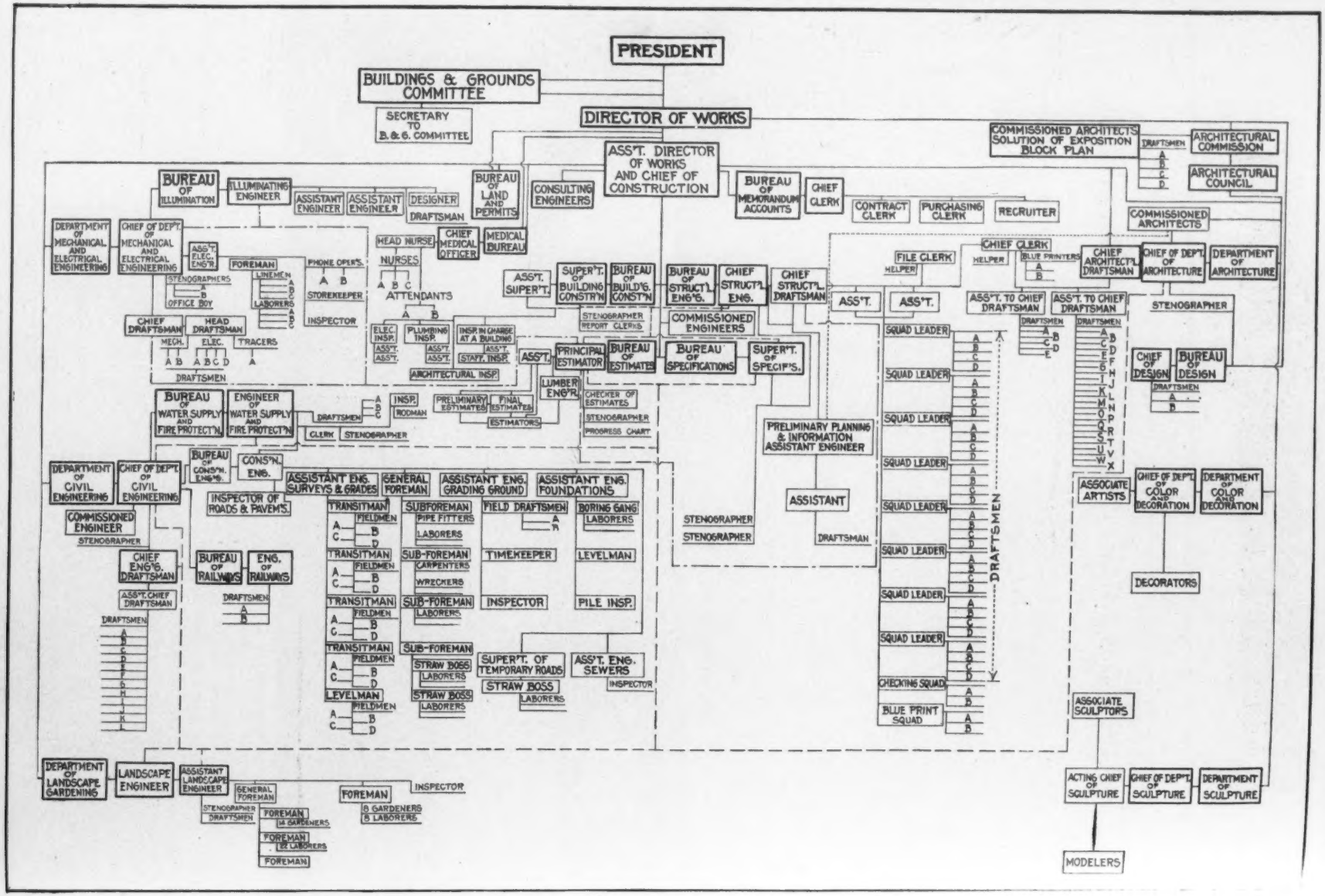

FIG. 2. ORGANIZATION CHART OF THE DIVISION OF WORKS OF THE PANAMA-PACIFIC INTERNATIONAL EXPOSITION

a force account under which is done such work as does not permit of the preparation of definite specifications. This includes laying plank roads, constructing temporary buildings, doing various work in connection with the moving of original buildings, and the clearing and grading of the site.

That the work is well under way is shown by the fact that up to July 30, 1913, there had been awarded 139 contracts which will represent an expenditure of $4,600,000, and 135 special contracts representing $600,000. The expenditures and obligations of the Division of Works in other directions amounts to about $1,500,000. In regard to the progress of the work, it can be stated that construction is farther advanced than it was at any other of the large expositions at relative periods in their history. Fig. 1 is a view showing the condition of the site and works on Apr. 2, 1913.

In view of the diversified work in connection with the construction of an exposition a rather unusual classification was necessary. In most engineering undertakings the work is essentially of one consecutive character. The enterprise in question is such that the requirements are not as definitely known as they are in most engineering works.

Very careful investigation was made of the construction items realized in previous expositions and preliminary budget allowances were based accordingly. In the construction estimate there was not included the operating expenses or maintenance during the exposition or the cost of removing exposition structures or the rehabilitation of the site after the exposition, it being assumed the gate and other receipts and salvage would furnish sufficient funds for these purposes.

For the general interest of the reader it is well to state that the estimated number of paid admissions is 10,000,000. The prices for single admissions are 50c. for individuals over 12 years, 25c. for children between 5 and 12, children under five years of age being admitted free.

Finance and Organization

The amount of money available on July, 1913, for the purposes of the exhibition was as follows: by subscription, $7,000,000; from the state (by direct taxation), $5,000,000; from the city (by sale of bonds), $5,000,000; bond premium, interest, etc., $350,000; total, $17,350,000. The budget or distribution of this amount is about as follows: preliminary expenses (to Sept. 30, 1911), $385,587; department expenses previous to the opening, $2,250,000; building and grounds, $12,000,000; auditorium (in San Francisco), $1,100,000; rents, taxes, buildings removed, real estate, $1,000,000; contingent expenses, $614,413. The concessions are expected to represent an investment of $4,000,000, and the gross cost to exhibitors of preparing, installing and maintaining the exhibits is estimated at $10 per sq.ft. The total expenditure within the exhibition boundaries is expected to reach a total of $50,000,000.

A corporation has been organized, with a President and Board of Directors, an Executive Committee and a comptroller. The President is Charles C. Moore. The business of the exposition is handled by four divisions: (1) exhibits, (2) exploitation, (3) works, (4) concessions and admissions. In these divisions there are departments for the supervision of exhibits, exploitation, construction and maintenance.

Organization of the Division of Works

The Division of Works is responsible for all construction, and is divided into six departments for the execution of work prior to the opening of the exposition. In addition there are several bureaus dealing with special features of the work. The Director of Works, H. D. H. Connick (formerly assistant city engineer of San Francisco), is the head of the division. He has general executive charge of all matters pertaining to the physical creation of the exhibition, and his duties involve dealings with exhibitors, concessioners, and others, as well as the major matters of construction and equipment. The scheme of organization is shown by the chart, Fig. 2. The departments noted above, with their bureaus, are as follows:

(1) *Department of Construction*—This has general charge of design, construction, contracts and estimates, and is under the writer as Assistant Director of Works.

(A) The Bureau of Structural Engineering is responsible for the design of all structural features and the preparation of engineering plans in connection with the buildings, and will also investigate all plans submitted by intending participants. H. D. Dewell is Chief Structural Engineer, and A. A. Brown, Chief Structural Draftsman. To expedite the work, the following engineers have been commissioned to prepare structural plans: Main Tower, J. D. Galloway; Horticultural Palace, C. H. Snyder; Fine Arts Palace, M. C. Couchot; Festival Hall, Richard G. Doerfling; Motor Transportation Palace, W. L. Huber.

(B) The Bureau of Building Construction (in charge of Wm. Waters) has to deal with the supervision and inspection of the work.

(C) The Bureau of Specifications deals with all specifications relative to building operations. It is headed by C. H. Alden.

(D) The Bureau of Estimates prepares all preliminary and working estimates and places all lumber orders. For any item of work a preliminary estimate is made from rough plans or sketches, and if this is within the sum allowed for this item, the working drawings and specifications are ordered and bids invited. While bids are being received, the Bureau prepares working estimates from the plans and specifications. This provides against pooling of contracts, while it gives assurance that the prices at which contracts are let provide for reasonable profit if the work is well handled. The exposition company furnishes all lumber. C. H. Munson is head of the bureau, and John F. Miller, as Lumber Engineer, has charge of all details concerning the lumber.

(E) The Bureau of Memorandum Accounts handles all such accounts in connection with the various contracts, there being a contract clerk who acts in conjunction with the comptroller, through the assistant director of works. The comptroller makes all payments to contractors on certificates from the Division of Works, and has charge of all accountants in the main office. A. C. Emery is in charge of this bureau; he acts also as secretary of the Buildings and Grounds Committee and as chief clerk of the Division of Works.

(F) The Bureau of Lands, in connection with the Legal Department, handled the details involved in securing the site and has charge of the issuance of construction permits. R. C. MacLachlan is in charge.

(G) The Medical Bureau has charge of the hospital

in a wing of the Service Building, and takes care of persons injured during the construction work. It is headed by Dr. Woodward of the U. S. Marine Hospital Service.

(2) *Department of Civil Engineering*—This has to handle the filling and grading of the site, the design and construction of railways, roads, sewers and water-supply, and the supervision of all surveying and day-labor work done by the Division of Works. This department is in charge of E. E. Carpenter, Chief Civil Engineer; Joseph Schiffers is Chief Draftsman; and H. C. Holmes, as Consulting Engineer, has charge of preparing plans for wharves and slips on the water front.

(H) The Bureau of Engineering Construction (under Shirley Baker) deals with field work relative to surveys, establishing grades, handling force account and supervising the work done under this department.

(I) The Bureau of Water Supply and Fire Protection (W. M. Johnson) has charge of matters relative to fire prevention and protection, and looks after the design and installation of the high- and low-pressure water dis-

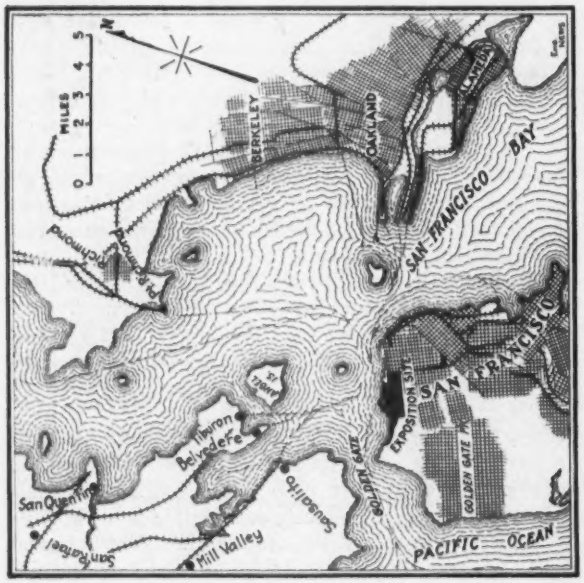

FIG. 3. MAP OF SAN FRANCISCO, CAL., AND NEIGHBORHOOD, SHOWING THE SITE OF THE EXPOSITION

tribution systems. It has charge also of all fire apparatus and collaborates with other bureaus in fire-prevention matters relative to building design and construction. It is expected to reduce the fire hazard and the insurance rates to a minimum.

(J) The Bureau of Railways (L. F. Champion) has to deal with the transportation system for handling the construction materials and the exhibits.

(3) *Department of Mechanical and Electrical Engineering*—This deals with the overhead and underground distribution systems for electricity, gas, steam and compressed air; also the wiring of buildings and grounds. G. L. Bayley is Chief Electrical and Mechanical Engineer; L. F. Leury is assistant in charge of the force-account work and inspection, and Henry Bosch, Jr., is chief draftsman.

(K) The Bureau of Illumination, dealing with the illuminating scheme, is in charge of W. D'A. Ryan.

(4) *Department of Landscape Engineering*—This has charge of the general landscape design, the movi and transplanting of trees, the lawns and horticultu features. It is in charge of John McLaren, Superinte ent of Parks of San Francisco.

(5) *Department of Architecture*—There was ori nally an architectural commission of three members: W lis Polk, W. B. Faville and Clarence Ward. The com mission later appointed a council of nine members, a the latter has elected Geo. W. Kelham, one of its mem bers, as Chief of Architecture. W. H. H. Weatherw is Chief Architectural Draftsman, and has charge of the preparation of contract and working drawings for the architectural features. The Division of Works also em ployed E. H. Bennett to prepare the block plan of the exposition, under the direction of the original architec tural commission. Eight members of the council are responsible for individual features, and certain other ar chitects were commissioned to design other features. The list is as follows, the architects whose names are marked with a star being members of the architectural council of the exposition:

W. B. Faville*	Exterior wall of the main group of buildings
Clarence R. Ward*	Machinery Building
Geo. W. Kelham*	Courts of Palms and Flowers
Carrère & Hastings*	Main Tower
McKim, Mead & White*	Court of Honor
Henry Bacon*	Court of the Four Seasons
Louis C. Mullgardt*	Court of Abundance
Robert D. Farquhar*	Festival Hall
Bakewell & Brown	Horticultural Building
G. Albert Lansburgh	Motor Transportation Building
B. H. Maybeck	Fine Arts Building

(L) The Bureau of Design deals with the connecting links of the various units and with details not assigned to special architects. This is in charge of E. F. Champney.

(6) *Department of Color and Decoration*—This is in charge of Jules Guerin.

(7) *Department of Sculpture*—This is headed by Karl T. F. Bitter, with A. Stirling Calder as acting chief of the department.

SITE

The site selected for the exposition is on the "harbor-view" lands and parts of the Presidio and Fort Mason military reservations at the north end of the city, fronting on San Francisco Bay, and affording fine water views across the bay. This is shown by Figs. 1 and 3. It is accessible by both land and water transportation. The site has an area of 625 acres, with an east-and-west length of 2¾ miles, and two miles of water front. The topography is mainly flat, with a slight fall toward the water front, but it is surrounded by steep hills on the three land sides. There are, however, some slight elevations, the maximum height being 82 ft. above sea-level. Part of the site has had to be filled in by hydraulic dredges, depositing about 1,700,000 cu.yd. of sand and silt at a cost of $301,000. All structures will be on pile foundations, however, so that the settlement of this fill will affect only the roads and surface work.

Outside of the U. S. Government Reserve the area acquired is about 76 city blocks, partly occupied by dwellings and improvements of various sorts. The property was either leased or purchased and the exposition company now owns 12¼ acres. Some of the improvements were sold by the company, but the revenue did not exceed $30,000, and the total expenditure for acquiring lands was $305,000. The total cost of the site, covering its use up to January, 1917, will amount to $1,000,000.

The distribution of that part of the area to be used for definite purposes is as follows:

	Acres
Exhibit palaces site proper	217.3
Concessions district	69.2
Foreign pavilion sites	49.7
State pavilion sites	42.3
Aviation field, drill ground and race tracks	37.7
Live-stock section	24.3
Railway yards and wharves and docks	17.1
U. S. Government exhibit	12.7
Street railway terminals	2.3
Life-saving station	1.1
Unappropriated, at western end	10.3
Total for definite purposes	484.0

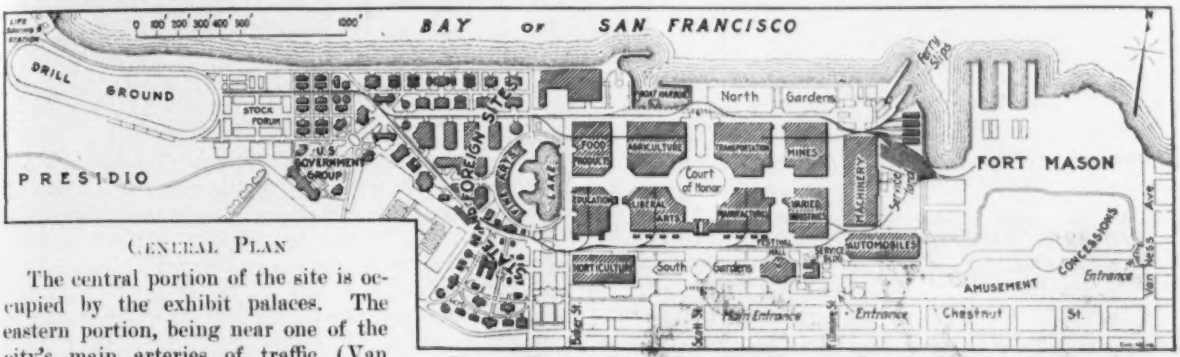

Fig. 4. Plan of the Panama-Pacific International Exposition

General Plan

The central portion of the site is occupied by the exhibit palaces. The eastern portion, being near one of the city's main arteries of traffic (Van Ness Ave.), is devoted to the amusement concessions. The Presidio, forming the western portion, being government territory, this was assumed to be the most logical area for the U. S. Government exhibit, and it was then desirable to locate the state and foreign governments in relation to it. Further west are the stock exhibit, race track and drill grounds. The main entrance is at Scott St., and subordinate entrances are provided at Fillmore and Baker Sts., and in the Presidio section. The principal water entrance is at the ferry slips, and this will be used by most of the visitors from the cities on the east and north sides of the bay. The general plan of the exposition is shown in Fig. 4, while Fig. 5 shows cross-sections on the main axes.

The main group of eight exposition palaces, covers approximately 43 acres. On the main axis (north and south) are the Main Entrance, the Great Tower and the Court of Honor (467,000 sq.ft.). The transverse axis passes through two subordinate but important courts and terminates in the Machinery Palace and Fine Arts Palace. It is thought that an extremely attractive and practical plan has been presented. The main group is set within a garden, with its area broken to afford space for the interior courts, which will be made features of great beauty.

The local climate conditions were considered in preparing the general plan, and though the climate is mild and equable there are frequently high winds from the west and occasionally from the north. There is also more or less fog. It is believed that the interior courts and the large area south of the main group will provide sheltered retiring spots when the high winds prevail.

A special feature of the arrangement is that the main buildings are only 150 ft. apart, while in previous expositions the distance has been 300 to 400 ft. This will greatly reduce the amount of walking on the part of visitors, while the extra fire risk due to the closer spacing has been provided for.

Architecture and Decorative Features

The architecture will not be confined to one style, but a satisfactory relation will be maintained between adjacent and attached structures. The architects have not been commissioned to prepare complete building plans, as at other expositions, but their function has been to design the exterior walls and courts, while the buildings proper (within the facade lines) are designed by the engineers. The entire exterior wall of the main group has been put in the hands of one architect, while others have been selected to design the facades of courts. An

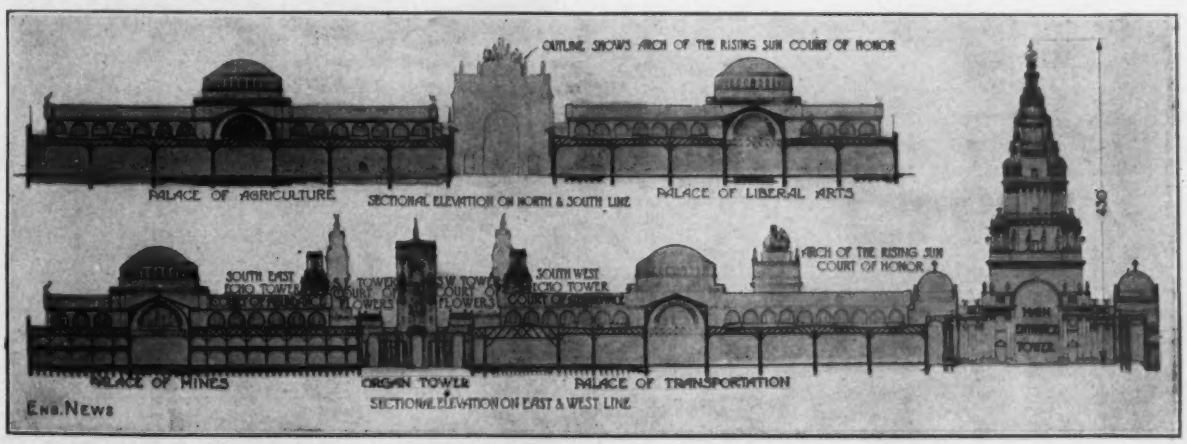
OUTLINE SHOWS ARCH OF THE RISING SUN COURT OF HONOR
PALACE OF AGRICULTURE
SECTIONAL ELEVATION ON NORTH & SOUTH LINE
PALACE OF LIBERAL ARTS
SOUTH EAST FOCO TOWER
S.W. TOWER
SOUTH WEST FOCO TOWER
ARCH OF THE RISING SUN COURT OF HONOR
MAIN ENTRANCE TOWER
PALACE OF MINES
ORGAN TOWER
PALACE OF TRANSPORTATION
SECTIONAL ELEVATION ON EAST & WEST LINE
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Fig. 5. Sectional Elevations through the Main Group of Buildings; Panama-Pacific International Exposition

TABLE I. DIMENSIONS OF MAIN BUILDINGS: PANAMA-PACIFIC INTERNATIONAL EXPOSITION

Buildings	Size ft.	Area sq.ft.	Volume 1000 cu.ft.	Foundations: Main structural frame	Foundations: Floor substructure	Live load on floors (4)
Education and Social Economy*	394x526	205,100	14,053	Piles	Spread footings	100
Food Products*	424x579	236,690	15,609	Piles	Spread footings	100
Agriculture*	579x639	328,633	20,634	Piles	Piles and sp.ft.	100
Liberal Arts*	475x585	251,300	16,038	Piles	Spread footings	150
Manufactures*	475x552	234,000	15,650	Piles	Piles	100
Varied Industries*	414x541	219,000	14,648	Piles	Piles	100
Mines and Metallurgy*	451x579	252,000	16,199	Piles	Piles	150
Transportation* (1)	579x614	314,000	20,413	Piles	Piles	100 (5)
Machinery	367x967	369,600	37,030	Piles	Mud sills	200
Festival Hall	276x386	.....	.....	Spread footings	Spread footings (3)	125
Horticulture	300x660	195,000	.....	Piles and sp.ft.	On ground	.....
Fine Arts	.....	126,000 (2)	.....	Piles	On ground	.....

* These are the eight buildings of the main group.
(1) The Motor Transportation building is a separate structure 257x792 ft.
(2) Area including colonnade and rotunda, 204,325 sq.ft.
(3) The dome is carried by piles.
(4) Live-load on roof, 20 lb. per sq. ft. on rafters and purlins, and for bending in top chords of trusses.
(5) Live-load 100 lb. on aisles; tracks, Cooper's E-60 and E-50.

entire court has been considered a decorative feature in itself and entrusted to one designer. All architectural features outside of the main group are cared for in the usual manner, and each building is designed completely by one architect. The principal structures under this

FIG. 6. MAIN FRONT OF THE PALACE OF MACHINERY; PANAMA-PACIFIC INTERNATIONAL EXPOSITION
(Copyright by the Exposition)

scheme will be the palaces of Machinery, Horticulture and Fine Arts, the Festival Hall, and the California Building.

The main group comprises the following eight exhibit palaces: (1) Education and Social Economy; (2) Food Products; (3) Agriculture; (4) Liberal Arts; (5) Manufactures; (6) Transportation; (7) Mines and Metallurgy; (8) Varied Industries. Integral features of this main group are the Great Tower, the Court of Honor and four lesser courts: Four Seasons, Abundance, Palms and Flowers. The Court of Honor is about 500x900 ft., with curved colonnades, on the east and west axes of which are triumphal arches 150 ft. high, surmounted by masses of sculpture. At its south end is the Great Tower, 433 ft. high, 125 ft. square at the base, with a vaulted opening 60 ft. wide and 110 ft. high passing through the base.

The east and west courts are each 340 ft. square. The total length of the main group (east and west) is 2756 ft., with a width of 1235 ft. at the west end and 1250 ft. at the east end.

The style of the exterior north and south walls of the main group is a liberal treatment of the Spanish renaissance, while the east and west walls are after the style of the Italian renaissance. In the interior treatment, the principal features are the longitudinal and transverse aisles, with a dome as a dominant feature at their intersection. The aisles have arched trusses, as shown in Fig. 7.

The dimensions and other features of the main buildings are given in Table I. In all the buildings, the height in the main portion is 40 ft. from the floor to the lower chords of trusses, and 65 ft. from floor to cornice (exterior), while the trusses average 10 ft. in depth. In the clearstory of each building the height is 96 ft. from floor to ridge (exterior), 79 ft. to eaves or cornice, and 160 ft. to springing line and top of dome, the diameter of dome being 110 ft.

The Palace of Machinery, Figs. 6 and 7, is the largest frame building ever constructed, in point of cubic contents and amount of material used. It has three arched aisles 75 ft. wide and 101 ft. high, extending its entire length, while on each side is an aisle 70 ft. wide with a shed roof 41 ft. high. There are also three transverse

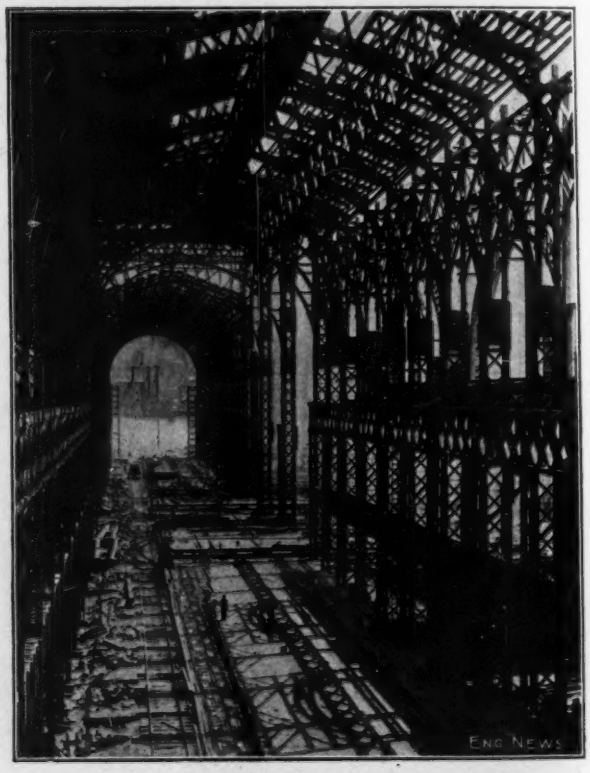


FIG. 7. INTERIOR OF THE PALACE OF MACHINERY UNDER CONSTRUCTION
(Looking down one of the aisles)

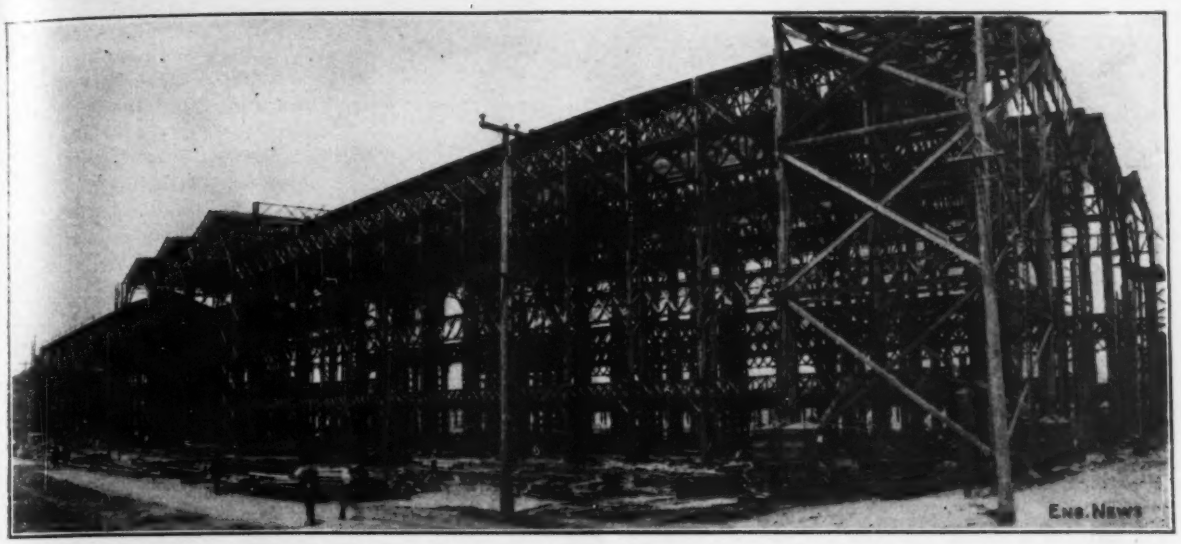


FIG. 8. TIMBER FRAMING OF THE PALACE OF MACHINERY AT THE PANAMA-PACIFIC EXPOSITION, SAN FRANCISCO, CALIF.

(This is said to be the largest wood-frame building ever erected.)

aisles or transepts 75 ft. wide and 132 ft. high. The Palace of Horticulture is 185½ ft. high to the top of a main dome 152 ft. diameter. The Festival Hall is 321 ft. high to the top of the dome, 170 ft. diameter.

The Service Building, in which the Division of Works is housed, is a two-story and attic building, U-shaped in plan, 170 ft. long, with a court 104x60 ft.

A special feature is the construction in the city of San Francisco of an Auditorium for use by conventions, music festivals, etc., in connection with the exposition. This will be a permanent structure, forming one of the proposed group of buildings for the Civic Center. It will be 275x412 ft., covering an entire city block, and its main hall will seat 10,000 persons. The architects (who also constitute the city's Civic Center Commission) are John Galen Howard, Frederick Meyer and John Reid, Jr.

COLOR SCHEME

For the exterior color scheme of the buildings, a treatment in imitation of Roman travertine marble has been adopted. This will have no distinct sharp color, but comprises warm tones of grey and pink blended together. This artificial representation of travertine was employed first in the Pennsylvania R.R. station at New York, by Paul E. Denivelle, who originated and is in supervision of the plastic scheme for the exposition. Additional color will be used in the courts (on the walls behind the colonnades) and on the domes and other distinctive features, while mural paintings by prominent architects will be employed in appropriate places.

The decorative scheme includes the coloring of roof surfaces and roadways, while the Landscape Department will maintain a green effect throughout the year, and this will be a component part of the color scheme.

HORTICULTURE AND SCULPTURE

An elaborate horticultural treatment is planned and involves extensive work since the site consisted mainly of sand and was in general barren of foliage. About 50,000 cu.yd. of loam will be required, 20,000 to be obtained near the site and the remainder brought by water from a point on the San Joaquin River about 70 miles distant. In addition, about 16,000 cu.yd. of fertilizer will be required. There is opportunity for the use of varied kinds of plants, as some areas have a bleak exposure while others are sheltered. Large temporary gardens have been formed, and greenhouses built, in order to prepare the necessary shrubs, bedding plants, etc. There will be some 60 acres of gardens, and it is planned to maintain a bright display of color by means of flowering shrubs and plants.

There will be a considerable amount of sculpture, by sculptors of note, in the form of fountains, groups of statuary, colossal figures, etc., arranged in the grounds and as part of the treatment of the buildings and their approaches. There will be a great fountain representing the creation of the isthmian waterway between the oceans, and also two fountains symbolical of the rising and setting sun, while the sculptured features of the triumphal arches in the Court of Honor will represent the nations of the East and of the West.

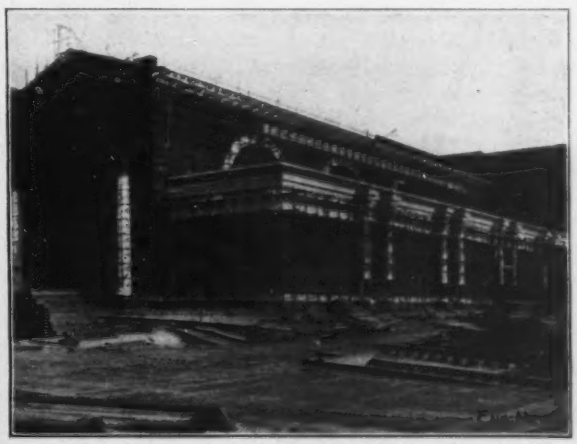


FIG. 9. PLACING THE EXTERIOR DECORATION ON THE PALACE OF MACHINERY

Structural Design of Buildings

A few of the buildings are of steel-frame construction. In the others, a timber frame supports a wall built of wood studding covered with sheathing and the imitation marble already noted. The cornices, architectural columns, decorative ceiling, etc., are cast from molds and secured to a wood skeleton frame. For other work, the plaster composition (a gypsum product) is applied directly to the grooved sheathing, the second coat being of a colored mixture with a suitable proportion of sand and finished with the desired texture in imitation of marble. The casts are made in glue molds, the first step being to lay on the light and dark veining by means of special veining cans. Then a slightly damp mixture is applied where indentations are desired (the mixture taking a permanent set at once), and upon this is laid a thin backing of the same mixture, but in a more liquid condition. The full thickness of the cast, ¾ to 2 in., is then made up with uncolored mixture, reinforced in the usual way with jute and fiber.

All exterior windows will be fitted with translucent glass instead of clear glass. The buildings are covered with a prepared roofing, having an asbestos top sheet painted with fire-retardant paint of desired colors. About 20% of roof surface will consist of skylights glazed with ¼-in. ribbed wire-glass. At former expositions, asbestos covering has not been used and skylights have been mainly of translucent fabric, but the construction described gives much greater fire protection.

The buildings will require about 70,000,000 ft. b.m. of lumber ranging from 1x4 in., 6 ft. long, to 70-ft. timbers 12x12 and 16x16 in. Most of the sizes used are not carried in stock by local yards and had to be cut to order. The timber is mainly Douglas fir, from Oregon and Washington, and is shipped in steam schooners from the mills to the dock at the exposition site.

The cost of the main exhibit palaces is given in Table II. The general contract figures include one track extending across the building, with a siding and two unloading platforms; the exposition company furnishes rails and track fastenings. The contractor furnishes all other material and does all erection. The figures do not include the courts. The plumbing figures include the cost of the fixtures (which will be furnished free of charge by the concessionaires for lavatories and public comfort stations), the non-automatic cornice sprinklers, the mains to connect with interior automatic sprinklers, and the high- and low-pressure water piping, with hydrants and hose equipment.

The two 30-ton and two 20-ton traveling cranes in the Machinery Palace will cost $25,000, and the transfer table in the Transportation Palace will cost $12,000. The item prices for foundation piles are from 23.3 to 31c. per lin.ft., and for lumber are from $16.80 to $19.13 per M. b.m.

The engineers furnished foundation, floor-framing and roof-framing plans, with sufficient sections and elevations to show all main framing, the contractors being required to furnish detail drawings for approval. For the few steel-frame buildings the details are in accordance with standards of practice as given in commercial handbooks. For timber and concrete construction the connections were shown more in detail. The Bureau of Structural Engineering detailed an architectural engineer to work with the several architects and obtain information as to location of posts, openings in walls, special architectural motives, and other matters affecting the structural framework. The information was turned over to the structural squads and very rapid execution of contract drawings resulted. This method eliminated the delays usually occurring in the development of engineering plans in connection with architectural work. For timber work, the drawings were in general on a scale of ½ in. to the foot, while details of steel work were shown at 1 in. to the foot.

Foundations

The site is composed of filled ground on tide flats, part of this filling being done by the exposition company by means of suction dredges. This fill is composed of about 70% sand and 30% silt and sea deposit. The material beneath the fill is clay mixed with blue mud, underlaid by a bed of green sand and clay, and finally by hardpan at a depth of 30 to 120 ft. from the surface. Tests on the fill of dredged material showed a supporting power of only about 400 lb. per sq.ft., which prohibited the use of spread footings. The settling also tended to carry down the test piles, so that unless piles were sufficiently long they would sink more rapidly than the fill when subjected to loads. The engineers were forced to the conclusion, therefore, that it would be inadvisable to carry any given load by skin friction of the piles alone. In view of the great number of piles required, economy in length was an important consideration and it was decided to drive all piles into the green sand and clay (above the hardpan) to a penetration of 1 in. at the last blow. The soil underlying the areas not filled was in general yellow beach sand, soft clay and sand, hard green sand and clay, and finally yellow hardpan.

It was decided to use piles for the support of all building walls and special loads over the entire site, for three reasons: (1) uniformity of construction, (2) greater safety in case of earthquake, (3) a spread footing designed for a bearing of 3000 lb. per sq.ft. on the sand would cost as much as (or more than) a pile footing. The length of piles varies from 16 to 75 ft., but in all cases a load of 20 tons per pile was assumed. This may seem strange, since the value of the pile depends usually upon the skin friction and the length, but tests confirmed the selection of this unit load.

The floors are generally suported independently of the

TABLE II. COST OF BUILDINGS OF THE PANAMA-PACIFIC INTERNATIONAL EXPOSITION

Building	General contract	Piling	Plumbing	Electrical work	Lumber	Roof painting	Other painting	Incidentals	Total	Per sq.ft of floor area
Education	$198,704	$3,114	$15,911	$10,000	$62,030	$1500	$5000	$10,500	$304,263	$1.48
Food Products	222,092	2,696	16,350	13,000	73,181	2000	6000	8,000	342,551	1.45
Agriculture	257,596	13,861	24,410	11,000	91,259	2500	8000	16,000	425,610	1.30
Liberal Arts	227,802	3,100	21,000	10,000	72,478	1500	5000	6,400	344,180	1.37
Manufactures	215,326	14,216	19,811	11,000	62,016	1500	5000	12,200	341,069	1.46
Varied Industries	193,329	9,786	15,050	11,000	61,455	1500	5000	13,571	312,691	1.43
Mines	219,638	18,640	15,147	11,000	70,664	1500	5000	17,856	359,445	1.43
Transportation	254,615	64,395	19,300	15,000	92,932	2000	6500	14,935	481,677	1.53
Machinery	449,048	11,748	25,500	35,000	124,347	2500	8500	12,000	659,665	1.78
Festival Hall	.....	.....	.....	.....	.....	.....	.....	.....	270,000	4.70
Horticulture	.....	.....	.....	.....	.....	.....	.....	.....	341,000	1.70
Fine Arts	.....	.....	.....	.....	.....	.....	.....	.....	580,000	2.84

piers carrying the structural frame. For spread footings, there are joists 2x8 in., 24 in. c. to c., 9-ft. span; and girders 6x8 in., 9-ft. span. For pile footings the joists are 2x12 in., 24 in. c. to c., 14-ft. span; and the girders 10x16 in., 20-ft. span. There is a 2-in. underfloor, with 1-in. dressed-and-matched flooring in the aisles. The roofs have 1-in. shiplap sheathing supported on the roof joists or rafters and purlins, which are 24 in. c. to c. The roofing has been mentioned already.

Loads and Stresses

The live loads on the floors are given in Table I. For the roof, it is taken as 20 lb. per sq.ft. on rafters and purlins and for bending in top chords of trusses. Wind pressure was taken as 20 lb. per sq.ft. of vertical walls up to 150 ft., and 25 lb. for higher walls, with roofs computed by Duchemin's formula for wind normal to roof (with $P = 30$ lb.). All roof trusses are designed for the following conditions: (1) dead-load plus 15 lb. live-load, total not to be less than 35 lb. per sq.ft.; (2) dead-load plus wind load. The assumed weights are 3 lb. per board-foot for lumber, 5 lb. per sq.ft. for plaster composition, and 20 lb. per sq.ft. (or 100 lb. per cu.ft.) for cast composition.

Unit Stresses

Special attention was paid to the determination of unit stresses to be used in wood, and after careful discussion an extreme fiber stress of 1500 lb. for cross-bending was adopted. This was exceeded in the case of floors, as noted below. This may seem low in view of the temporary character of this construction, but whether temporary or permanent the loads must be cared for. All the structural lumber was imported direct from the mills and was all fresh cuts, the mill run and of "merchantable" grade. In a number of instances this merchantable material would have been rejected had the work been of more permanent character. The consideration of these facts resulted in the selection of the unit stress above mentioned.

The allowable stresses for steel are those given in Ketchum's "Steel Mill Buildings," with some modifications. Those for concrete and reinforced concrete are as given in the majority report of the committee of the American Society of Civil Engineers.* For Douglas fir: tension with grain, 1200 lb. per sq.in.; compression and bearing, 1600; compression across grain, 350; transverse, extreme fiber (except in floors), 1500; modulus of elasticity, 1,000,000 dead-load, 1,500,000 live-load; shearing with grain, 150. All unit stresses were increased 25% for wind. The 1500 lb. for extreme fiber stress in timber is more or less theoretical as far as the floors are concerned, as for these it was in many cases increased to 1800 lb. for reasons of economy, especially as the floors are to be reinforced wherever exhibits cause an excess over the established live-load.

Columns were considered as fixed at the ends, where provision could be made for providing the condition of fixedness. Special attention was paid to the transfer of the stresses to the flanges of columns to resist wind bending. Where bending due to wind occurs, the combined stress due to dead-load and bending does not exceed the safe stress as given by the column formula, increased 25%, considering the width of column in the plane of bending. The maximum ratio of length of timber to its least width is 60. The maximum length of timber to be used generally for chords of trusses was taken as 36 ft. A maximum length of 70 ft. was used in special occasions.

The general type of splice for tension has two wooden splice plates, on either side of a main member, with 2-in. pins. The value of one pin was taken at 800 lb. per lin.in. The total stress in the bolts through the splice plate, on either side of the joint, was considered equal to half the total stress transmitted by the splice. Where possible, splices were arranged so that pins were horizontal, to prevent falling of pins due to shrinkage. A number of full-sized tests, using various materials for pins, were made to confirm the selection of this type of joint.

The area of holes for bolts and rods through compression members of timber was deducted to obtain the net section to resist compression. The area taken out of upper chords of timber trusses by butt blocks of web members was not deducted in computing the chord to resist bending due to transverse loading between panel points, and such chords were considered as continuous beams.

All bolts and rods are supplied with cast-iron washers, except that where the diameter of washer was greater than width of timber, steel plates were used of sufficient area to provide bearing against the grain of the wood at 350 lb. per sq.in., to the amount of the value of the rod in tension at 16,000 lb. per sq.in. All rods in trusses are of steel or refined iron with upset ends not forged on, and computed at 16,000 lb. per sq.in. They are assumed to have a 3000-lb. initial tension at 16,000 lb., which is equivalent to an addition of 0.1875 sq.in. above the areas required by the stresses.

All joints of end posts of trusses with the lower chord have shoe plates with lugs, or other suitable connection, furnishing definite lines of action, but such joints were assumed to be simple joints and to depend upon only one type of detail for resistance. For example, if a shoe plate with lugs into the lower chord was used, these lugs were taken to furnish all resistance, with none of the horizontal stress in the lower chord taken by the inclined bolts.

Whenever a steel or wooden plate is bolted to a timber, and where the thickness of such plate is not over 2 in. and the corresponding width of timber to which plate is bolted is at least 6 in., the bending in bolts was neglected and the bolts proportioned only for shear and bearing. When, however, the thickness of the plate exceeds 2 in., the bolts were figured to take bending at 25,000 lb. Where possible, field connections of steel to steel were designed for bolt or pin connections.

In the buildings of former expositions, two lines of studs laced together have been used. One line of studs is here used, braced against wind by horizontal girders spanning between posts at about 13-ft. intervals. All studding is 2x4 or 2x6 in., as determined by loads of walls, resistance to flexure by wind, and by size necessary for nailing at connection to frame. It is bridged horizontally at 6-ft. intervals. Diagonal bracing is also provided in the walls. Floor and roof joists are bridged over supports by solid bridging, and at intervals of approximately 8 ft. c. to c. by solid or herringbone bridging.

*"Transactions," American Society of Civil Engineers, Vol. LXVI, 1910.

The lateral resistance of nails was taken as eight times the penny designation of the nail. The lateral resistance of lag screws in steel plates to wood, and in wood tie-plates 2 in. thick and less, was taken as ranging from 700 lb. for screws $\frac{3}{8}$x3$\frac{1}{2}$ in. to 2800 lb. for $\frac{7}{8}$x5 in.

[*A second part of this paper by Mr. Markwart will deal with the electric light and power, decorative illumination, water-supply, fire protection, sewerage, paving and transportation facilities.—Editor.*]

Partial Failure of a Light Highway Bridge

By F. Tissington*

There has recently come to the attention of the writer a highway bridge about sixteen years old, which has failed to act structurally as designed, but which is still carrying its load in a manner unforeseen by its designers. As an instance of the effect of the mutual support which one member of a riveted-truss system has upon another, it is very interesting.

Fig. 1 shows an elevation and plan (with flooring removed) of the truss of the bridge in question. It is an ordinary riveted pony truss highway span 49 ft. 6 in.

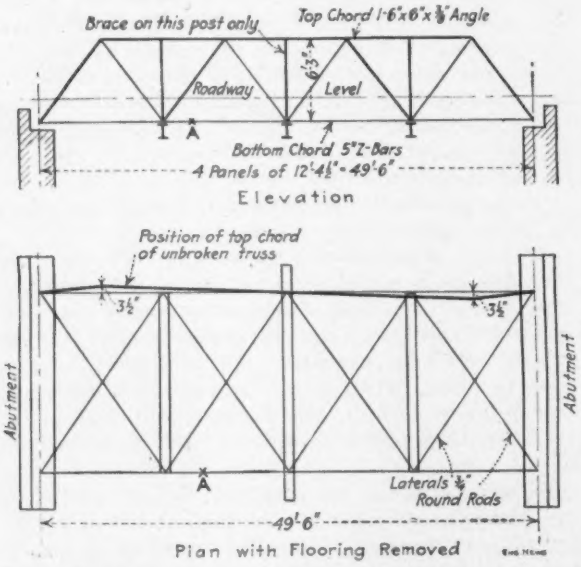


Fig. 1. Plan and Elevation of a Theoretically Weak Highway-Truss Bridge Which Is Still Standing

long, with a 14-ft. roadway on a timber floor, as shown in the half cross-section in Fig. 2. In the truss system the lower chord is a Z-bar, the verticals, diagonals and upper chord are single angles, the floor beams are I-beams, and the lower laterals round rods. The Z-bar lower chord of the trusses has its upper flange straightened vertically in plane with the web at each of the post connections, and this flange is riveted directly to the post angles, no gusset plates being used. The only transverse bracing to the top chord is the knee brace at the center of the truss shown in Fig. 2.

Recently the flooring was relaid, and while this work was being carried out it was found that the bottom chord of one of the trusses was broken clean through a [illegible] point marked *A* on Fig. 1. Upon investigation it appeared as though this had occurred some time before, and the fracture apparently painted over. Notwithstanding this fact, the bridge is still performing its duty. Further investigation showed that previous to the removal of the timber floor an average depth of about 10 in. of sand had been removed from the floor surface, this sand having washed down upon the bridge from the approaches.

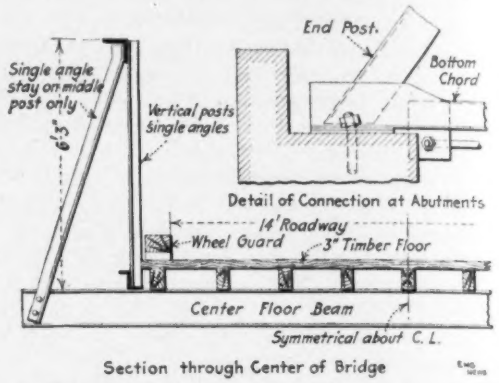


Fig. 2. Half Cross-Section and Detail of End-Post Connection of Highway Bridge

ing roads which slope down to it on either side. This material would add roughly about 100 lb. per sq.ft. of roadway to the dead load of the bridge. It was found also that the top chord of the unbroken truss had deviated, rotating around the middle of the chord, about 3½ in. on either side of its original center line, as shown in the plan in Fig. 1.

Examination of the anchorage of the trusses disclosed the fact that the anchor bolts retaining each end of the bridge were approximately in their right location, but that the ends of these anchors where they projected above the masonry were bent in the manner indicated in the detail in Fig. 2. The lateral plates, as shown on the same figure, had a hard bearing against the masonry; in fact they seem to have cut into the abutments to some considerable extent.

It seems almost impossible from a theoretical standpoint that *without* the break referred to the bridge could have carried its own dead weight, the traffic of the district, and the added load due to the sand referred to; in fact, from the condition of the sound truss it looks as though the structure was ready to fall at any time. The only explanation the writer can see for the non-failure of the other truss is that the top chord was transformed into a flat arch, and the remaining part of the structure suspended from it.

An investigation of the truss will show that the top chord has a stress nearly twice the permissible stress in such a member, considering the very high value of $\frac{l}{r}$ for this member, assuming an unsupported length of 12.4 ft., the panel length. Further, by a rigid analysis there is no lateral support of this upper chord between the connection of the end post on the abutment and the outside stay in the center of the truss, thus making the unsupported length of the top chord rather more than twice that used in figuring the above stress.

The municipality which owns the bridge does not seem

*79 Drummond Road, Sherbrooke, Que.

to be concerned about it and is preparing to replace the broken lower chord in its original dimensions and design.

The Deficient Rainfall in the Summer of 1913

The summer of 1913 (May, June, July and August) was notable for its light rainfall in many sections of the United States, particularly in the corn and wheat belt, which suffered a severe drought accompanied by as trying heat. The average precipitation in inches in the 12 states of the corn and wheat belt compared with the normal precipitation is shown in Table I. The same data for the Atlantic and Gulf states are given in Table II.

The normal precipitation in each case is based upon records which extend over more than ten years from stations of the United States Weather Bureau. The figures for May and June are taken from the "Monthly Weather Review" of the Weather Bureau and represent the averages of a great many stations in each state. The "Review" for July and August had not been issued when our tables were compiled and the figures which we print for those months were obtained from the record file of the Weather Bureau station in New York City. The records cover only a few of the more important stations in each state, but these points are so distributed that they allow of a fair approximation of rainfall conditions throughout the state.

Of the states in the corn and wheat districts, Kansas and Missouri report the most abnormal conditions; each falls approximately 8 in. short of the usual summer rainfall. Minnesota is about normal, while Wisconsin is above by nearly 2 in. The section average is below normal for each month except May, when by some chance it was exactly normal. The average deficiency for the section was 3.64 in.

Among the states listed in Table II, Arkansas holds the drought record by falling more than 7 in. below the normal rainfall. The section average was consistently below normal during the entire summer; and the average deficiency for the section was 3.56 in. If, however, the Arkansas record were included with the corn and wheat belt group, where in some respects it perhaps more properly belongs, the average rainfall for the last named section would be even lower.

TABLE I. SUMMER RAINFALL IN 1913 IN THE CORN AND WHEAT BELT

State	May		June		July		August		Total for four months		Departure from normal
	1913	Normal	1913	Normal	1913	Normal	1913	Normal	1913	Normal	
Illinois	3.04	4.00	2.47	3.73	2.33	3.22	2.27	2.86	10.11	13.81	—3.70
Indiana	2.79	4.20	2.10	4.03	2.76	3.97	3.26	3.29	10.91	15.49	—4.58
Iowa	6.21	4.50	3.32	4.52	1.39	3.81	2.73	3.33	13.65	16.16	—2.51
Kansas	3.04	3.85	2.44	4.12	1.20	3.94	0.53	3.25	7.21	15.16	—7.95
Kentucky	2.95	3.98	2.82	4.24	1.73	3.70	1.70	3.36	9.20	15.28	—6.08
Minnesota	3.53	3.26	3.08	3.84	5.80	3.71	1.90	3.44	14.31	14.25	+0.08
Missouri	3.05	4.98	2.57	4.79	2.76	4.09	0.97	3.63	9.35	17.49	—8.14
Nebraska	3.60	3.40	2.73	3.73	1.86	3.61	0.72	3.12	8.91	13.86	—4.95
Ohio	3.53	3.65	1.87	4.13	3.10	3.54	2.30	3.13	10.80	14.45	—3.65
Wisconsin	5.50	3.51	3.10	3.83	5.76	3.60	1.67	3.20	16.03	14.14	+1.89
North Dakota	1.68	2.57	2.35	3.44	2.31	3.27	3.09	2.29	9.43	11.57	—2.14
South Dakota	3.48	2.54	2.50	3.61	1.52	2.81	1.84	2.41	9.34	11.37	—2.03
Average rainfall for section	3.70	3.70	2.61	4.00	2.71	3.60	1.91	3.10	10.77	14.41	—3.64

TABLE II. SUMMER RAINFALL IN 1913 IN THE ATLANTIC AND GULF STATES

Section	May		June		July		August		Totals for four months		Departure from normal
	1913	Normal	1913	Normal	1913	Normal	1913	Normal	1913	Normal	
New England	3.32	3.59	1.28	3.10	2.25	3.39	2.15	3.59	9.00	13.67	—4.67
New Jersey	3.45	3.91	1.80	3.84	2.59	4.50	3.37	4.75	11.21	17.00	—5.79
New York	3.08	3.53	2.00	3.87	1.78	3.56	2.27	3.12	9.13	14.08	—4.95
Pennsylvania	3.86	3.96	2.26	4.01	3.37	3.92	2.54	3.73	12.03	15.62	—3.59
Maryland and Delaware	4.30	3.61	2.27	4.02	2.63	4.82	6.38	4.21	15.58	16.66	—1.08
West Virginia	5.16	3.90	3.44	4.78	6.66	4.65	4.56	3.65	19.82	16.98	+2.84
Virginia	5.48	4.04	3.91	4.59	4.17	4.73	3.99	4.60	17.55	17.96	—0.41
North Carolina	4.37	4.07	4.93	4.73	5.00	5.82	4.02	5.61	18.32	20.23	—1.91
South Carolina	2.13	3.52	5.53	4.06	5.84	6.20	3.40	6.71	16.90	20.49	—3.59
Georgia	2.27	3.47	4.83	4.75	5.64	5.23	3.69	5.36	16.43	18.81	—2.38
Florida	3.08	4.04	5.11	7.31	6.06	7.29	6.27	7.39	20.52	26.03	—5.51
Tennessee	3.93	4.25	2.53	4.57	4.54	3.99	1.93	3.61	12.93	16.42	—3.49
Alabama	3.14	4.04	3.54	4.26	3.89	5.29	2.54	5.50	13.11	19.09	—5.98
Mississippi	4.01	4.27	2.12	4.51	2.91	4.46	2.07	3.54	11.12	16.78	—5.66
Louisiana	4.95	4.33	3.72	5.28	3.03	5.10	3.59	3.93	15.29	18.64	—3.35
Arkansas	3.32	5.39	1.68	4.22	4.02	4.05	1.08	3.78	10.10	17.44	—7.34
Average rainfall for section	3.74	3.99	3.18	4.43	4.02	4.81	3.37	4.57	14.31	17.87	—3.56

An Employment Department has been organized by the Oregon Society of Engineers. The department and the reasons for its establishment are explained as follows:

The marketing of technical ability is carried on in a manner so crude and inefficient that were any one of us to take charge of a piece of work and find any of the details connected therewith being done so wastefully, he would be spurred into immediate action, and would give the subject his best thought until a satisfactory solution had been found. But with the matter of "getting a job," and the other matter of securing satisfactory help in an undertaking that is of more than "one-man size" we are most lax. Realizing this condition, the Executive Board of the Oregon Society of Engineers authorized the secretary to keep a roster of such of the members as were open for offers of employment in any capality, and there are now on file the names and qualifications of about 40 members, representing practically every branch of the engineering profession in all the grades from draftsman and levelman, to consulting engineer. The service of the employment department is free to all members of the society, and is intended to be of assistance to those desiring to secure efficient help, as well as to aid any member in getting employment. The procedure is: securing the name, address, telephone number, technical training and professional experience, of a member, as well as any other information that might help a prospective client or employer to reach a preliminary decision as to a man's ability and fitness for the particular work in hand. This information is classified under as many heads as is thought desirable, and filed in a card index.

Grade-Crossing Elimination in St. Louis, Mo., is now under discussion, and reports have been made to the Missouri Public Service Commission by J. L. Harrop, its engineer. If the recommendations of the report are adopted there will be some extensive work in grade separation, but as several of the railways concerned are in the hands of receivers it may be difficult to finance any work that the commission may order. However, plans and estimates for the work will be prepared, together with the apportionment of cost, so that when conditions are favorable there will be no preliminary work or difference of opinion to delay the construction. The city, the Missouri Pacific Ry. and the St. Louis & San Francisco Ry. reached an agreement some time ago as to eliminating the Tower Grove crossing, and this work will be started very soon. The railway will bear the entire cost, exclusive of consequential damages.

Shifting the Girders and Columns of the Chicago Elevated Railway

The revision of street-car routes in the downtown district of Chicago (about two years ago) necessitated the introduction of a number of connecting curves at street intersections. Owing to conditions of the width of streets these curves in many cases approach very close to the curb line, and at some points the path described by the long cars in passing the curve covered the positions occupied by columns supporting the structure of the elevated railway loop. This necessitated some interesting structural changes to the elevated structure, and still more interesting work in making these changes without interfering with traffic on either the elevated road or the surface tracks.

The general design of the elevated structure consists of two rows of columns (either on the curb line in narrow streets or in the roadway in wide streets) with transverse plate girders framed between them, and with longitudinal trusses or track stringers framed between the transverse girders. Horizontal bracing extends from the columns to the track stringers. The length of the cross girders varies from 41 to 51 ft. (between the columns) and their depth is 7 ft. The normal span of the longitudinal trusses is 50 ft., and the depth 5 ft. The column construction consists of a 15-in. I-beam (with web parallel to the line of the structure) having two 15-in. channels riveted to its flanges; the channel flanges are inward, and are connected by batten plates. Curved knee braces extend from the face of the column (the I-beam web) to the bottom chord of the cross girders. The minimum headway above the street level is 14 ft.

In general, the reconstruction work at each point was as follows: (1) supporting the stringers by timber bents on blocking; (2) removing one old column (or sometimes both columns), with the cross-girder and bracing; (3) setting the new column or columns; (4) placing the new and longer girder and adjusting the track stringers to it; (5) putting in the new bracing.

At some of these points the work was complicated by the fact that stations and platform girders were carried upon the cross-girder to be renewed.

At Adams St. and Fifth Ave., the cross-girders of two adjacent bents were 51 ft. long c. to c., of columns, and each had to be lengthened to 65 ft., the lengthening being at opposite ends, as shown in Fig. 1. As each girder is lengthened at one end only, and the track stringers remain unaltered, the loading is eccentric. Each of the new girders (Fig. 2) has a web plate 84x$\frac{7}{16}$ in., with flange angles 8x8 in., and three cover plates at top and bottom, the cover plates being unsymmetrical in regard to the length of girder, as shown.

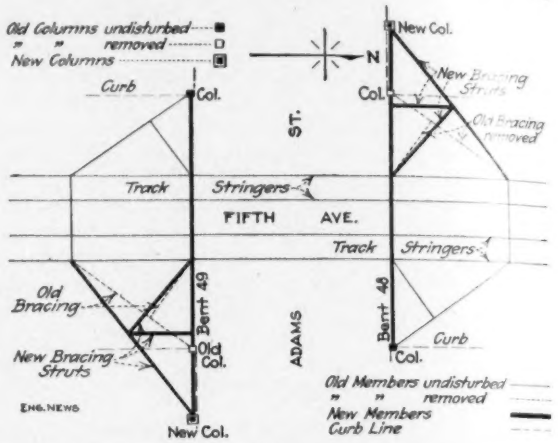


FIG. 1. PLAN SHOWING ALTERATIONS TO THE CHICAGO ELEVATED LOOP STRUCTURE AT FIFTH AVE. AND ADAMS ST.

At Dearborn and Lake Sts., one column had to be shifted no less than 29 ft., and the girder increased in length from 22.8 ft. to 51.8 ft., the track stringers remaining in the same position and the load being thus concentrated at one end of the girder. To stiffen the cross-girders where of such length, latticed bracing was

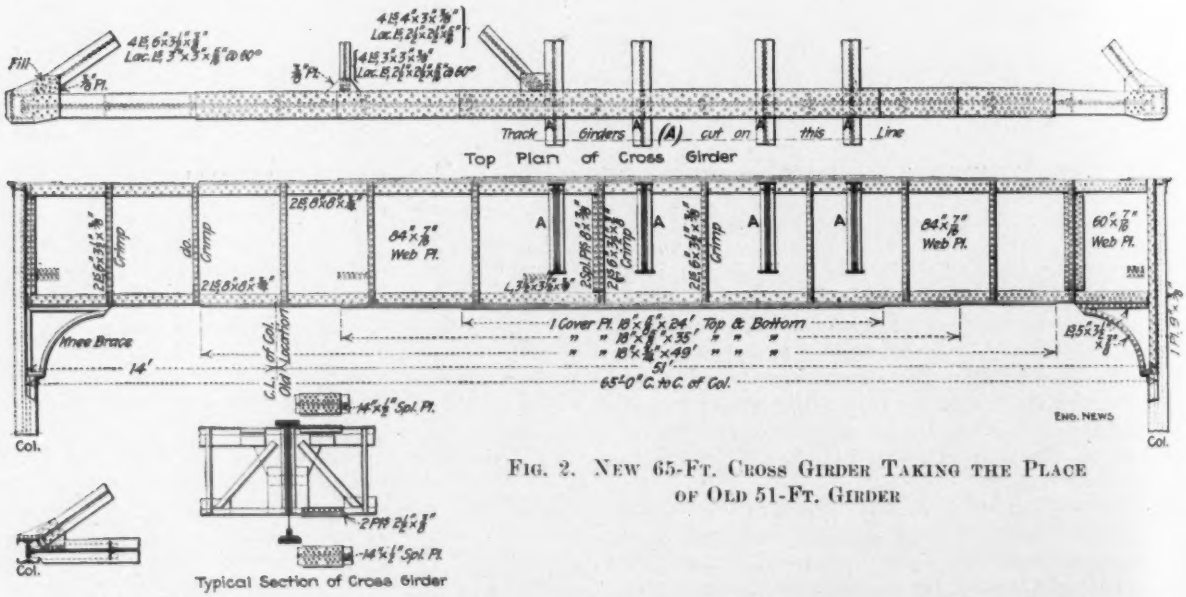

Fill
Track Girders (A) cut on this Line
Top Plan of Cross Girder
84" x 7/8" Web Pl.
60" x 7/8" Web Pl.
Knee Brace
14'
51'
65'-0" C. to C. of Col.
1 Cover Pl. 18" x 7/8" x 24', Top & Bottom
" " 18" x 7/8" x 35' " " "
" " 18" x 7/8" x 49' " " "
C.L. of Old Location
14" x 7/8" Spl. Pl.
2 Pls 24" x 7/8"
Col.
ENG. NEWS
Typical Section of Cross Girder

FIG. 2. NEW 65-FT. CROSS GIRDER TAKING THE PLACE OF OLD 51-FT. GIRDER

carried from each column to the track stringers at a point 15 to 25 ft. from the column, and cross frames and diagonal bracing were placed between the track stringers at these points, the whole forming a truss about the cross-girder.

At Lake and State Sts., the changes were numerous, as shown in Fig. 3. The location of two bents (Nos. 46 and 50) had to be changed entirely, and these new bents had columns spaced 50 ft. apart, instead of 22 ft. as in the old bents. In addition, these new bents were set back 2 ft. and 4½ ft. from the position of the old bents, which increased the span of the track girders to 53 ft. 9 in. in one case and 52 ft. 7¾ in. in the other, so that these girders had to be renewed. For one of these spans new track girders were required, while for the other span the old girders were cut and remodeled. These track girders are shown in Fig. 4. The old material was cut away with an oxyacetylene torch, which was used also to cut the track stringers, this cut being made at about 15 in. from the ends.

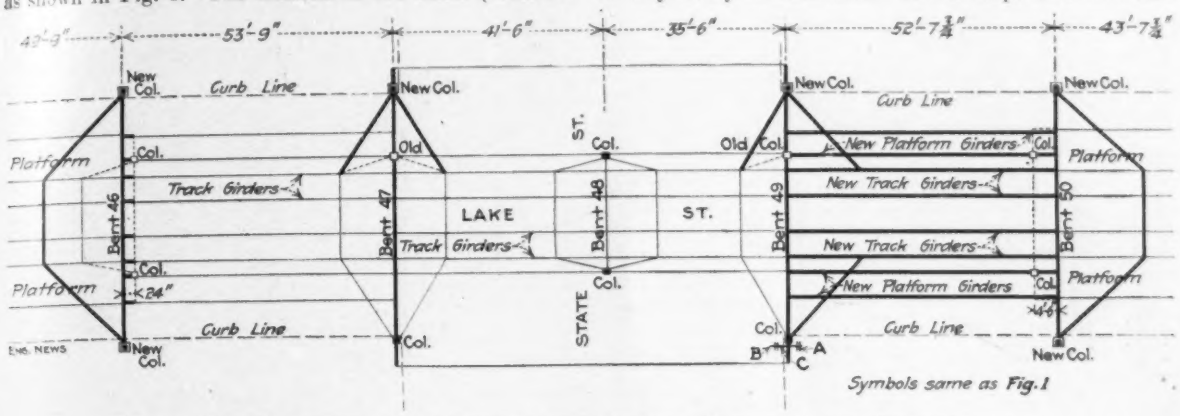


FIG. 3. PLAN SHOWING ALTERATIONS TO THE CHICAGO ELEVATED LOOP STRUCTURE AT LAKE AND STATE STS.

One point of special interest was a bent at Dearborn and Van Buren Sts., where both columns had to be removed and the span of the cross-girder increased from 40 ft. 3 in. to 70 ft., as shown in Fig. 5. This bent (No. 18) carried a station and platform, and the depth of girder could not be increased, being limited by the track grade on top and the street headway beneath. The new 70-ft. girder, therefore, is built in the form of a truss, with a solid web-plate in the middle panels, and while the bottom chord is horizontal the upper chord is raised at the ends, where it lies beneath the station buildings, and the load is carried by diagonal members. This arrangement, which is shown in Fig. 6, was necessitated by plans for additional entrance and exit passages which would have been cut off by a solid-web plate girder. The design adopted allows these passages to go through the open panels, between the top and bottom chords of the girder.

It will be seen by the drawing that this truss-girder is of very heavy construction. It was deposited in Dearborn St., on the outer side of the loop structure, in line with its position in the structure, and was then raised by jacks and blocking. When at the proper elevation it was slid horizontally into position. This method of handling avoided interference with traffic on the surface tracks. The longitudinal girder between the tracks, and resting on the cross girder, is one of the supports for the bridge which lies beneath the tracks and connects with the stairways to the streets and the station platforms.

The column foundations are concrete pedestals, which have their tops at about the level of the base of the paving, and which extend normally to about 10 ft. below the paving. In nearly all cases there was trouble in finding a suitable location for the new columns owing to the existence of restaurants, storerooms, walls of sub-sidewalk vaults, hydrants, catchbasins, gas mains, water mains, etc. This necessitated a careful survey of each location and at some points catchbasins or the manholes of public-utility corporations had to be moved. In some cases, also, the column had to be carried down through the vault space to a deeper foundation, while in other cases

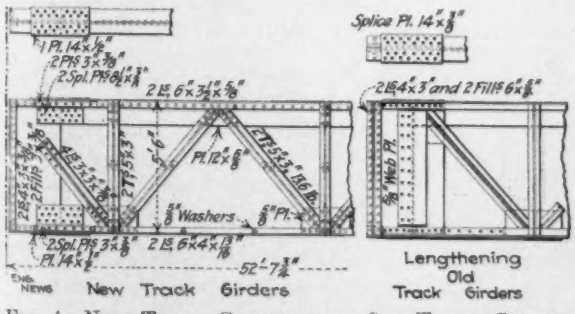


FIG. 4. NEW TRACK GIRDERS, AND OLD TRACK GIRDERS LENGTHENED BY SPLICING AN ADDITION AT THE END

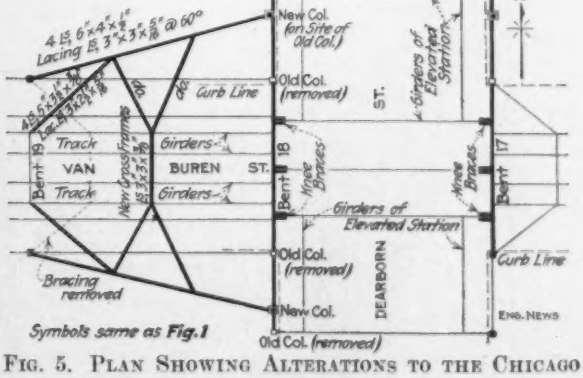


FIG. 5. PLAN SHOWING ALTERATIONS TO THE CHICAGO ELEVATED LOOP STRUCTURE AT DEARBORN AND VAN BUREN STS.

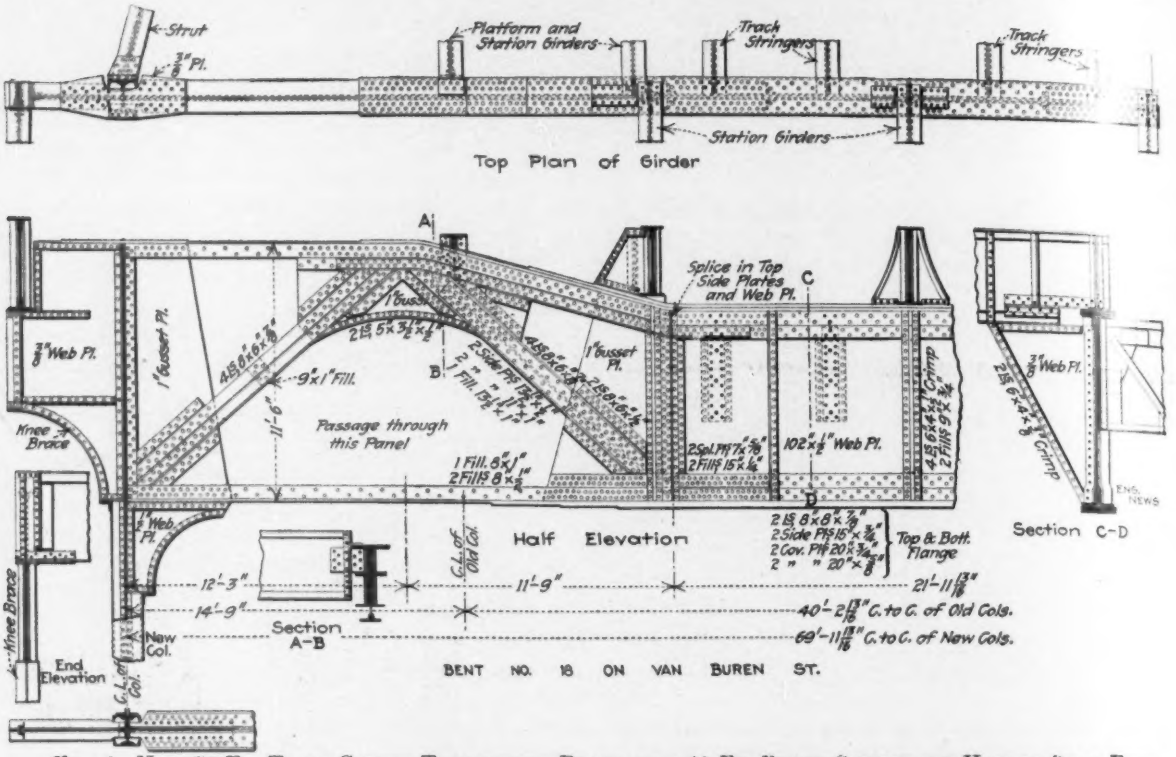


FIG. 6. NEW 70-FT. TRUSS-GIRDER TAKING THE PLACE OF A 40-FT. PLATE GIRDER AND HAVING OPEN END PANELS TO ACCOMMODATE PASSAGES LEADING TO THE STATION

existing walls (generally in poor condition) had to be partly cut away to make room for the new pedestal.

The first stage of the work at any one point was to build the new column foundation, or underpin the old one and add a larger footing beneath it. Then the cross-girder was supported at one or both ends (according to whether one or both columns were to be removed) by a timber bent supported on blocking and jacks. The end connections to the column were then cut loose, and the nuts on the anchor bolts removed, allowing the column to be swung out by a hand derrick. The new column was hauled into place by wagon and erected usually by means of a portable steam derrick. To replace the cross-girders, the ends of the track stringers on each side of the girder were supported by beams and blocking on bents placed as nearly under them as the street-car tracks would permit. The stringer connections were then cut, and the cross-girder removed in one piece, which was handled and lowered by cribbing and jacks.

The new girder was brought in and deposited in the street, being then raised into position with cribbing and jacks. It was found early in the work that hoisting with

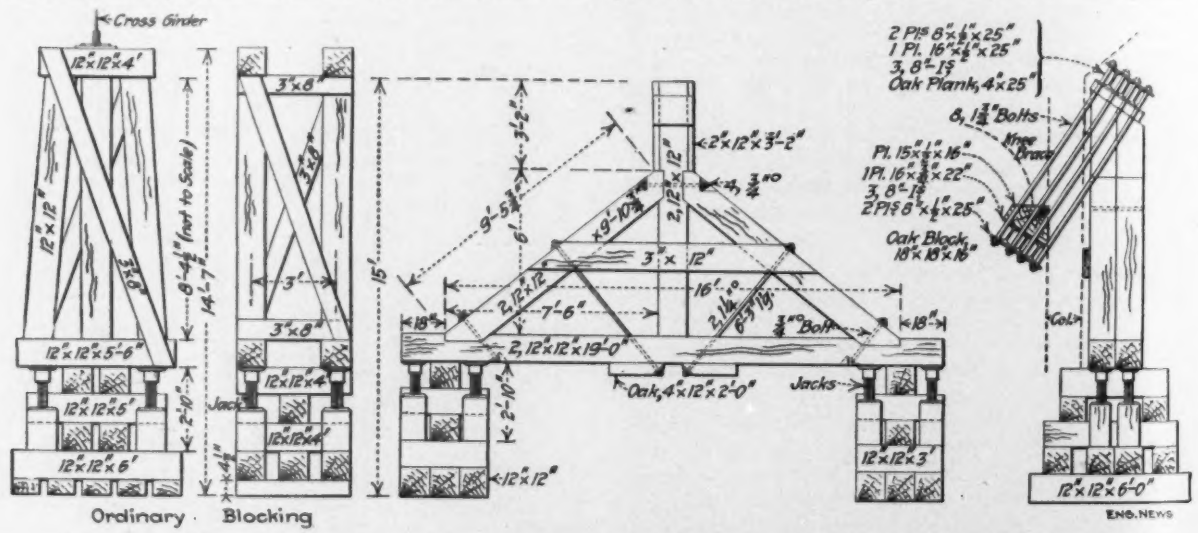


FIG. 7. BLOCKING BENTS USED TO SUPPORT THE ELEVATED STRUCTURE DURING ALTERATIONS; AND A SPECIAL TRUSS BENT USED WHERE THERE WAS NO ROOM FOR THE ORDINARY BENTS

derricks was impracticable. The steel was all removed at night and nearly all of the foundations were put in during the night.

In the case of the south column of bent No. 49 at Lake and State Sts. (Fig. 3), the ordinary blocking bent described above could not be used, owing to the existence of a surface-track junction curve approaching close to the curb and column. This column was not to be moved, but required to have the foundation reinforced. For this work two sets of blocking were built, *A* and *B*, one being on the sidewalk, so that the sub-sidewalk space beneath it had to be timbered. Upon the blocking rested the ends of a triangular or A-frame truss *C*, the middle being close against the back of the column.

The details of this construction are shown in Fig. 7. Across the top of the center post of the truss were three 8-in. I-beams, with anchor plates for eight 1¾-in. bolts, 8 ft. 2 in. long, which extended in an inclined position past the column (four on each side of the column). The lower ends of these bolts carried another cross-piece composed of 8-in. I-beams with anchor plates. The inner plate supported an oak saddle composed of pieces of 2-in. plank, having the grain parallel with the hanger rods. This was cut to fit against the face of the column and the bottom of the knee-brace connecting the column with the cross-girder, a ½-in. steel plate being fitted between the saddle and the knee-brace.

The nuts on the anchor bolts were then slackened and the bent jacked up so as to take the load off the foundation and transfer it to the hanger bolts and the timber truss. A pit was excavated around the pedestal, and the latter undermined for one-third its length, several jacks being set under to hold it. The next third was then excavated and supported, and finally the last third. The pier was then jacked up slightly and nine vertical pieces of 6-in. I-beam set beneath it, with bearing plates at top and bottom, and steel wedges under the bottom. When these supports were wedged up, the jacks were removed and the space well filled with concrete to form an additional footing course with greater bearing area.

The difficulties of performing the work were considerable, as it had to be done without interfering with traffic on the elevated railway or the surface lines, and with as little obstruction to street traffic as possible. Part of the work was done at night.

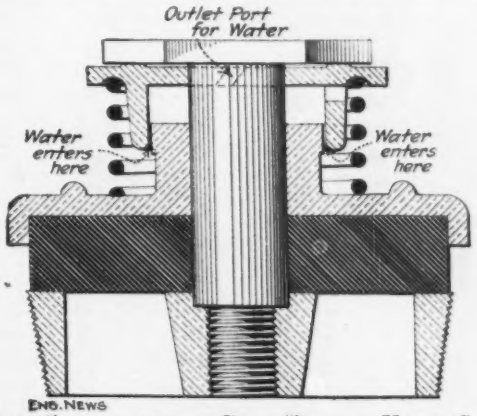
The contract for carrying out this work was let by the Northwestern Elevated R.R. Co. to the firm of Geo. W. Jackson (Inc.), Chicago, which also built all the new steelwork at its own shops. The plans were made and the execution of the work carried out subject to the approval of the engineers of the Board of Supervising Engineers (Chicago Traction) and of the elevated railway company. For information and drawings we are indebted to E. A. Clark, of the contracting firm, and C. M. Mock, chief engineer of the Northwestern Elevated Ry.

A Pump-Valve Seat Which Rotates Its Valve to Produce Uniform Wear

A new valve seat for pumping-engine valves has recently been developed, which is claimed to effect a saving in life, slippage and friction of the rubber valve. With the common straight port seat, the water passes through the port vertically, striking the valve at right angles producing considerable friction. As the valve closes on the same spot at each stroke of the pump the pressure soon indents the rubber with the ports of the seat, and results in leaks.

The new valve with its seat consists of six parts as shown in the cross-section. The lowest element in the drawing is the seat with ports so formed as to give the water a spiral twist in passing through. The rubber valve rests upon this seat; above the valve is a guard plate of the same material as the seat, and fitted with a plunger which works within a spring collar. The latter is just below the hexagonal portion of the stem, and separated from the guard-plate by a spring.

Because of the spiral inclination of the passages through the seat, the water strikes the valve at an acute angle, tending to rotate it. When the valve leaves the seat, the plunger enters the spring collar, forcing the water within the cylinder of the spring collar out through



CROSS-SECTION OF THE BOYD TURBINE VALVE SEAT WITH VALVE IN PLACE

angular ports and beneath the lower surface of the stem. This water forms a film between the stem and the collar, when the speed is normal, reducing the friction and allowing the valve to rotate. Therefore, with each stroke of the piston, the valve rotates a fractional amount between two films of water, but sufficiently to result in the uniform wear of the valve, and also a tight seat. The rotation of the valve at each opening is the basic principle of the valve. The device is the invention of the late John Robotham, and is manufactured by James Boyd & Bro., Philadelphia, Penn.

Expert Witness Fees of Engineers in Great Britain—A special committee of representatives of the Institution of Naval Architects, the North East Coast Institution of Engineers and Shipbuilders, and the Institution of Engineers and Shipbuilders in Scotland, has been formed to consult as to whether representation should not be made to the Board of Trade regarding the inadequacy of fees to professional witnesses. This question has been under consideration for some months past. It arose from a complaint made by an association of shipbuilders that the allowance for expert witnesses was inadequate. The Merchant Shipping Act, 1894, provides for the payment of expenses in respect of the attendance of witnesses at Board of Trade inquiries on the same scale as in the ordinary courts. The Board, however, allow only $15.75 and first-class railway fare. Under the County Court rules and the High Court Orders, which apply to Board of Trade inquiries as well as to the ordinary courts, an extra fee of from $5.25 to $26.25 may be obtained for "qualifying to give evidence." The Consultative Committee of the North-East Coast Institution of Engineers and Shipbuilders think that while the Board of Trade has no jurisdiction to raise the fees proper, they might in practice allow expert witnesses and leading officials of shipbuilding firms attending inquiries and giving evidence an additional qualifying fee, in terms of the Rules of Court, of from $5.25 to $26.25, making a total of $21 to $42.—["Engineering."]

A Diversion Dam with Unusually High Steel Flashboards

By M. C. Hinderlider*

The writer read with interest the article by D. A. Watt, in Engineering News, Aug. 14, 1913, p. 282, describing the changeable crest or steel flashboards used in the development of the Mohawk River for the New York State Barge Canal. This type of structure in most respects conforms to the ideas which the writer had for a development on Grand River, Colo., made three years ago. The necessary expenditure, however, was too great for the case in question, which made it necessary to resort to other methods and designs.

The use of high flashboards or other similar devices for regulating the stage of streams for various purposes has received the serious study of most eminent engineers all over the world, and the writer believes that most members of the profession at least are loath to employ a movable crest for a dam, involving a considerable range of height, particularly where large volumes of water are to be handled, and any considerable amount of drift and débris or ice-floes are to be encountered. The experience of the writer in this connection on one important undertaking was in a way unique, and may be of interest to the profession and other readers of the Engineering News.

In connection with the designing and construction of a power plant in Western Colorado it was necessary to construct a diversion dam across Grand River, the largest stream in the state. At the location of the dam the river flows through a gorge approximately 2500 ft. deep, known as Grand River Cañon. The width of this gorge at the bottom affords barely enough room on the western or right-hand side for the single track of the Rio Grande Junction R.R. and on the opposite side for a power canal, in addition to that required by the channel of Grand River. The river at this point is 370 ft. wide at high-water stage and practically the same width at low water. The bed of the stream consists of a deep layer or deposit of river cobble rock, smooth boulders and coarse gravel with a small amount of river silt and fine sand, all overlying a bed of shale which in turn overlies sandstone.

The underlying shale on the east side of the river adjoining a vertical cliff of sandrock, extends out under the river for a distance of about 100 ft. and was readily available for the foundation of the dam with a nominal excavation of 5 or 6 ft. Beyond the latter point, however, the river has eroded the shaley formation to a much greater depth, reaching 20 ft. or more, near the west margin of the river alongside the aforementioned railroad. Over this formation has been deposited boulders, cobble rock, gravel, etc., leaving a generally uniform channel with a depth of water at low stages ranging from 1 to 7 ft. The discharge of the river ranges from about 1800 cu.ft. per sec. during the winter months to as much as 50,000 cu.ft. per sec. in the months of May and June, the fluctuation being generally gradual and due to the melting of the snows in the high mountains.

The diversion dam, as originally planned, consisted of a timber-crib rock-filled structure surmounted by a concrete crest having a maximum height above the bed of the stream of about 12 ft. For raising the surface of the river above the dam to the required height, flashboards 3 ft. high, of the needle variety, were to be used on the permanent crest of the dam. These plans had to be radically modified later, however, on account of opposition from the officials of the Denver & Rio Grande R.R. and the Colorado Midland Ry., which jointly own and operate the Rio Grande Junction R.R. adjoining the dam in question, and which constitutes a link in the transcontinental line of the Missouri Pacific and Denver & Rio Grande R.R. This track was located but a few feet above the highwater line at this point.

The company which was building the dam proposed to raise the railroad track to a point well above the new highwater line created by the construction of the dam. The most serious obstacle, however, was presented by a railroad tunnel about 800 ft. long located 1800 ft. upstream from the dam site. Around this tunnel Grand River makes a long detour of practically one mile. The contention of the railroad companies was that a dam of the height proposed would endanger, if not submerge, this tunnel by causing the river to back into the upper portal of the tunnel during high stages of flow. It being impracticable to extend the intake of the canal upstream

Fig. 1. View Looking across Grand River Canyon, Colorado, Showing Diversion Dam with Raised Flashboards

to a point above the tunnel or to raise the railroad through the tunnel, the only alternative left was to reduce the height of the permanent crest of the dam. This made it necessary to greatly increase the height of the flashboards or temporary crest of the dam and hence to materially change the type of the structures.

The dam as constructed consists of a combination crib, rock-filled and concrete structure 46 ft. wide on the base with an average height of about 6 ft. above the bed of the river.

Figs. 2 and 3 show the general design of this structure and the details of the flashboards used. The superstructure of the dam is built of 8x8-in. square spruce timbers, while the floor or base is built of 10x10-in. square timbers. The cribwork is held together by ¾x18-in. square-drift pins and ¾-in. rods and U-bolts. For the protection of the top of the dam against ice-floes and the swift current during high water, a reinforced-concrete crest 18 to 36 in. in thickness was placed on top of the cribs the full width of the dam. This concrete crest also provides a permanent base or foundation to which the flashboards are attached. This concrete crest is reinforced with ¾-in. twisted square bars, spaced 24

*Of Field, Fellows & Hinderlider Engineering Co., Denver, Colo.

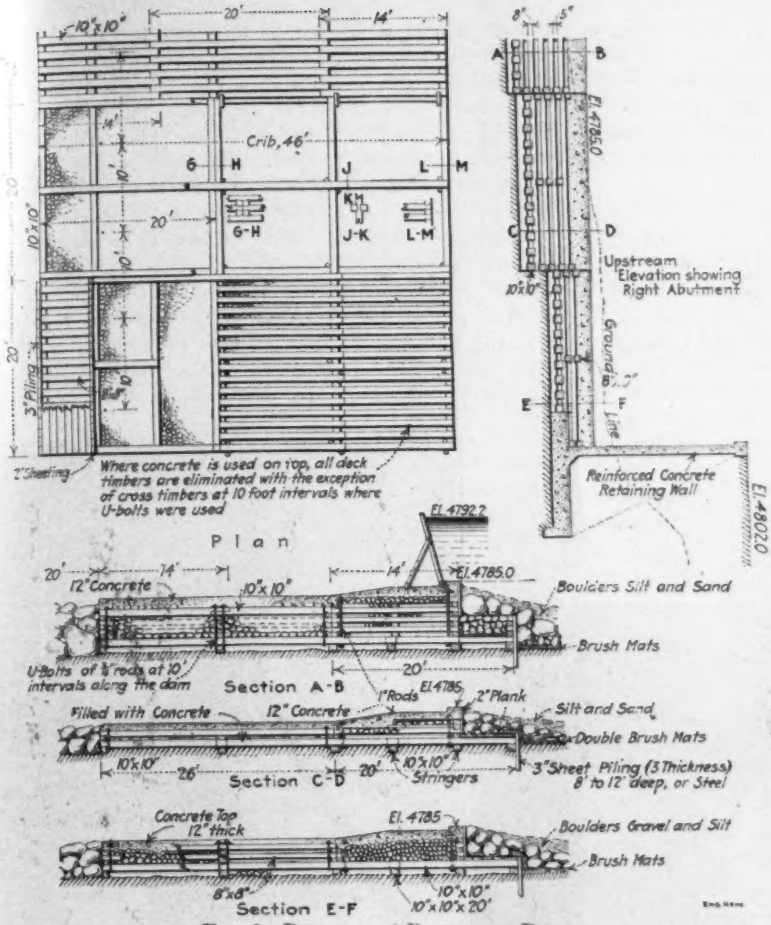

Plan
Crib, 46'
Where concrete is used on top, all deck timbers are eliminated with the exception of cross timbers at 10 foot intervals where U-bolts were used
Upstream Elevation showing Right Abutment
Reinforced Concrete Retaining Wall
Section A-B
Section C-D
Section E-F
Boulders Silt and Sand
Brush Mats
Silt and Sand
Double Brush Mats
3"Sheet Piling (3 Thickness) 8' to 12' deep, or Steel
Boulders Gravel and Silt
Concrete Top 12" thick
Filled with Concrete
12" Concrete
U-Bolts of ⅝" rods at 10' intervals along the dam
10"x10" Stringers

FIG. 2. DETAILS OF DIVERSION DAM

in. on centers both in the lower and upper face of the concrete slab and held together by means of steel hooks of the same size metal placed every 6 ft. About one-half of the total length of the dam proper, or 180 ft., is built of cribs as heretofore described. On account of the shallowness of the river channel a portion of the remainder of the dam was built of concrete laid on the heavy cobble rock bed of the river and protected at the upper and lower toe with reinforced-concrete curtain walls carried well below the bed of the stream. About 100 ft. of the easterly end of the dam rests on hard shale, to which the concrete body is securely anchored.

The original plans contemplated the use of wooden sheet-piling along the upper face of the dam to prevent underscour. It was found, however, that the formation precluded the use of wooden sheet-piling. Interlocking steel piling was substituted therefor and driven along the upper face of the dam to depths of from 8 to 14 ft. below the bed of the river where the loose material required piling.

The cribs were built in sections 20 ft. wide and 46 ft. long a short distance above the dam, and floated into place by means of a 70-hp. double-drum steam hoist and necessary cables. When adjusted to position they were filled by means of push cars with stone taken from a quarry located at the east end of the dam, this quarry later forming the location and foundation for the concrete headworks of the power canal.

As no means were available for diverting the river, on account of the limited room on either side, the first half of the dam was built directly out into the current, after which the river was diverted by means of a cofferdam of loose rock, earth and lumber, back over the finished portion of the dam, and the remainder of the structure then completed. In addition to the sheet-piling used along the upper face of the dam, heavy mats of green willows woven into mattresses securely tied with No. 9 galvanized wire, were placed along the upper face of the dam and loaded down with large stones, earth and gravel. The idea was not to provide a water-tight structure, since about 75% of the normal discharge of the river is required below the dam by prior appropriations, but it was necessary to prevent any large amount of water passing under the structure to avoid erosion. Erosion along the lower toe of the dam is taken care of by the construction of a large timber cribwork located about 30 ft. below the dam. This cribwork is anchored to the dam by means of cables, and filled with stone. The space between the crib and the toe of the dam is also filled with loose stone, the purpose of the lower crib being to prevent the washing away of the loose riprap below the dam during flood stages in the river.

The flashboards or movable portion of the dam consist of 176 separate leaves or panels, each 23 in. wide by 8 ft. 4½ in. high, fastened to the top of the concrete crest near the upstream edge. These panels are built up of 3½x5x½-in. angles, over which is riveted

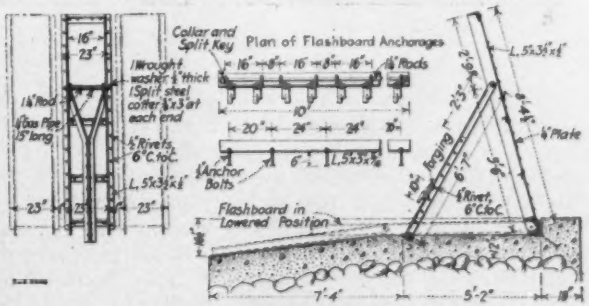


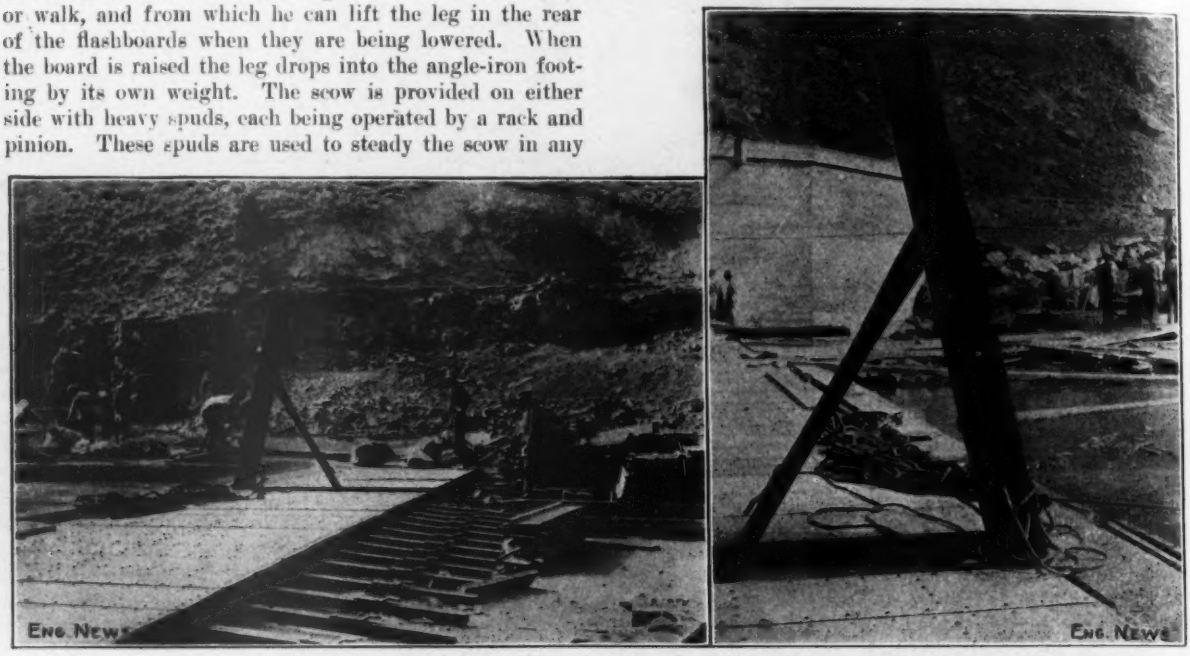
FIG. 3. DETAILS OF FLASHBOARDS

a ¼-in. steel plate. On the lower side of the panel is provided a split leg formed by two angle-irons, which is hinged to the flashboard panel about one-third the distance from the top, the lower end of which rests in an angle-iron embedded in the concrete crest. This leg supports the panel when raised to position and folds under the panel when lowered on the dam. The foot of the panel or flashboard is attached to the concrete chest of the dam by means of a milled steel rod 1¼ in. in diameter, which passes through holes in the lower ends of the ver-

tical angles forming a part of the panel, and through angle-iron lugs bolted to a 6x6x½-in. angle-iron embedded in the concrete crest of the dam, in such manner as to form a hinge joint. When standing, these panels or boards are about 8 ft. high. When not in use during highwater stages or during the winter months the boards lie flat on the crest of the dam forming a smooth surface for the passage of water and ice-floes.

These flashboards are raised and lowered by means of a scow which is 18 ft. wide, 32 ft. long and about 4 ft. deep. On this scow is located a stiff-leg derrick equipped with two ordinary hoisting winches. A vertical boom in addition to the ordinary boom, is used. The foot of this vertical boom is equipped with a heavy forged-steel hook for grappling the top of the flashboards when the same are lowered or raised. A ladderway is fastened to the mast booms of the derrick along which a man can climb or walk, and from which he can lift the leg in the rear of the flashboards when they are being lowered. When the board is raised the leg drops into the angle-iron footing by its own weight. The scow is provided on either side with heavy spuds, each being operated by a rack and pinion. These spuds are used to steady the scow in any required position. A 1½-in. galvanized-steel cable extending across the river above the dam, carries a traveler which is attached to the scow by means of blocks and tackle which prevents the scow floating down over the dam. The wheels of this traveler are provided with a locking device operated by means of hand lines running to the scow, which holds the traveler in any desired position along the cable. The boards may also be raised by hand, three to four men being required. In this operation, the first board or panel adjoining either abutment is raised by means of a grappling iron, with a small block and tackle attached to the abutment of the dam, or, if the amount of water passing over the crest of the dam is not great, the board is readily raised by hand. As the raising of the boards proceeds across the dam, the men follow along behind the raised flashboards which deflect the current. The stage of the water above the dam gradually increases to a point where it becomes necessary to use a small block and tackle for raising the boards. This is done by simply hooking one of the blocks over the top of the last board raised and throwing a grappling iron or hook, over the downstream end of the flashboard or panel to be raised, after which the [illegible] is readily raised to position. The block and tackle is then disengaged from its anchorage, attached to the board just raised, and the operation continued until the boards necessary to bring the water above the dam to the proper stage are raised to position. When lowering the boards, the foot of the leg supporting the [illegible] is disengaged from the angle-iron footing in the concrete and the board allowed to fall.

The raising or lowering of these flashboards across a crest length of 350 ft. requires three or four men half a day. The flashboards are operated usually but twice each year and then only those in the center of the dam. At the beginning of the irrigation season a sufficient number of the boards are raised to increase the stage of the river above the dam to proper elevation, and these again are lowered gradually with the approach of high water, which occurs in May and June. After high water has subsided, the boards are again gradually raised as the requirements of the canal demand, and again lowered with the approach of winter, to prevent interference with ice-floes and gorges in the river.



FIGS. 4 AND 5. VIEWS OF FLASHBOARDS ERECTED

The accompanying views show clearly the design, character and operation of these flashboards, which are believed to be the only ones of just this type in operation in this country. At the time these flashboards were being designed by the writer, considerable opposition was interposed by the engineer for the irrigation district for which the dam was being built, his theory being that it would be impossible to raise or lift the boards from the lowered position with a sheet of water passing rapidly over the same, on account of the partial vacuum which the moving sheet of water would cause to form under each board. A serious dilemma was presented at this

stage of the operations, since upon the successful operation of these flashboards depended the saving of hundreds of acres of valuable orchards and crops. After these flashboards were installed they were found to work perfectly and have been in successful operation now for three years. While this dam and the flashboards were not designed with a view of allowing the water to rise above the tops of flashboards when standing, immediately upon completion of the dam the boards were all raised and the water allowed to pour over the tops of same for a depth of nearly 3 ft. for a period of several days. The writer understands that within the past year a majority of these flashboards were allowed to remain standing during the flood discharge of the river, which passed over the tops of same several feet in depth. These boards were also left standing during the passage of ice-floes last winter, which caused no injury to the same. Fig. 1 shows the water pouring over and through the slots between the boards. These jets between the boards gradually disappear, due to the closing of the slots with leaves, twigs and such débris gradually sucked into place by the force of the water, and as a result the boards become almost entirely water-tight after being raised a few days.

A Free Piston Gasoline Rock Drill*

A new gasoline rock drill has just been placed upon the market. The outfit is self-contained and consists of a gasoline drill, tripod or quarry bar, fuel and lubricant containers, ignition battery and water tank, and is shown assembled on a tripod in Fig. 1. Its internal construction is very simple, and consists of four moving parts: the piston rod to which are fitted two pistons; the rifling nut, and two make-and-break spark plugs.

The driving element of the drill consists of two two-cycle, three-port gasoline engines of the valveless type.

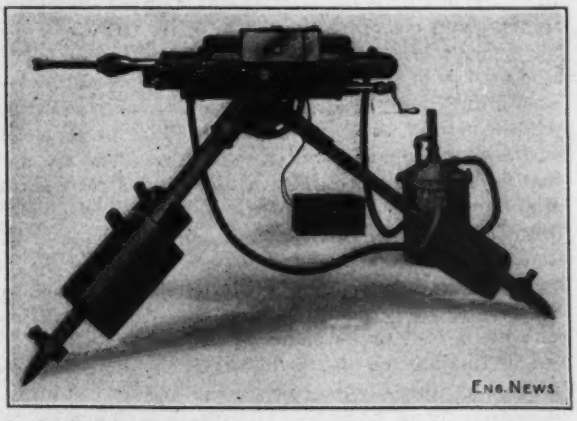


FIG. 1. THE RICE GASOLINE ROCK DRILL COMPLETE

Two opposing cylinders are butted together, end to end, and have a common piston rod, provided with two pistons, one for each cylinder. Reference to Fig. 2 will show the operation of the unit to be as follows:

A charge is compressed in the upper cylinder *A*, above the piston *B*. Upon the ignition of this charge the piston *B* is thrust downward, slightly compressing before it a charge of air and gasoline vapor which has been drawn into the space *C* of the same cylinder. The release of the gases of combustion is accomplished when the rear edge of the piston uncovers the port *D*. Almost simultaneously the port *E* is uncovered, which allows the slightly compressed charge contained in *C* to enter *A* in

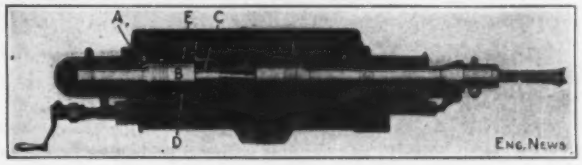


FIG. 2. CROSS-SECTION OF THE DRILL

an upward-moving direction, driving before it the remaining gases of combustion which escape through the port *D*. After the return stroke this compressed charge is ignited in the same manner as was the previous one. Before the return stroke is completed, however, a port not shown in this cross-section is uncovered by the piston and a fresh charge of air and gasoline vapor is admitted through the carburetor. The action in the lower cylinder is the same as in the upper but as the two cylinders are in opposition the several steps (as regard time) are not coincident.

The solid partition which is necessary for separating the two combustion spaces is further utilized by there arranging for giving to the plunger the required twist. For the normal stroke this twist is ⅛ revolution; it is directly proportional to the length of the stroke, which the drill runner regulates by means of the compression. This control of the length of the stroke is of great advantage in starting a hole or wherever else especial care and consequent slower speed is desirable.

Ignition is accomplished by means of an electric make-and-break sparking device actuated by triggers (one for each cylinder) in contact with the pistons. The revolution of the piston rod consequent to the action of the rifling device, distributes the trigger blows on the pistons, which results in the uniform wear of the latter. An ordinary plunger pump operated by a conical surface back of the chuck end of the drill plunger, supplies cooling water to the jacket.

The pistons, piston rod, rifling device and bit form one free-acting, full-floating piece (Fig. 2), delivering its blow to the rock as a unit. When the bit is not striking the rock the pistons air cushion; no springs are provided for this purpose. To start the drill, the operator has only to insert the starting handle and give the piston rod a thrust forward. The specifications of the drill as produced by The Rice Gasoline Rock Drill Co., of Philadelphia, Penn., are as follows:

Symbol indicating size and type drill	"B"
Diameter of cylinder	3¼ in.
Length of stroke	5 in.
Length of drill from end of crank to end of piston	48 in.
Depth of hole drilled without change of bit	24 in.
Approximate strokes per minute	600
Depth of vertical hole each machine will drill easily, from	1 to 24 ft.
Diameter of holes drilled as desired, from	1¼ to 2¼ in.
Diameter of octagon steel used	1⅛ or 1¼ in.
Size of shanks (diameter and length)	1 x 5 in.
Number of pieces in set of steels to drill holes to depths, as stated	12
Drill, unmounted, with wrenches and fittings, not boxed	310 lb.
Tripod, without weights, not boxed	275 lb.
Holding-down weights, not boxed	570 lb.

*The following matter on the subject of gasoline rock drills of various designs has been published in "Engineering News": "A New Gasoline Rock Drill," Apr. 13, 1905; "A Direct-Acting Gasoline Rock Drill," Nov. 26, 1908; "An English Gasoline Rock Drill," Nov. 17, 1910; "A Gasoline Rock Drill," Apr. 17, 1913.

Engineering English

By Harry R. O'Brien*

"There is a reproach attached to our engineering graduates, largely because they cannot express themselves in a written document," declared Professor J. J. Flather, of the University of Minnesota, in a discussion on Engineering English, at a recent meeting of the Society for the Promotion of Engineering Education. To drive home this statement, he tells that some years ago a request came to him for a graduate of the mechanical-engineering department. The only limitation imposed was that the applicant should be able to write English correctly. The position was that of assistant to the works manager "who wanted a man that could express himself properly in English." "There were twenty-six men who graduated that year but I could not recommend any one for the position," declared Professor Flather. Not long since, the department of English at the Massachusetts Institute of Technology issued a pamphlet in which were printed a number of letters of application which had been written by graduates of that institution in answer to an advertisement that appeared in Engineering News. These letters had been turned over to the department by a graduate now in a responsible engineering position, who had inserted the advertisement. Each of these letters had been written in such poor English that this alone had been sufficient to keep the writer from being employed for this $3000 position.

Instances such as the above might be multiplied indefinitely. What is true in regard to the graduates of these two great engineering schools, is true of practically every engineering school in the country. Engineers as a rule do not know how to use good English. They are weak in the most common fundamentals of grammar, punctuation and spelling. How to arrange a technical report according to the rules of unity, coherence and emphasis is beyond their utmost conception. The idea of filing a report on electrolysis at the general office or submitting specifications for building a concrete sewer, in clear, concise sentences and paragraphs, never enters their minds. These things are not by any means true of all engineers. Many of the older men in the profession use good English because they have served years of aprenticeship in the college of Hard Knocks. Among the younger men who have gone out from the engineering schools in the past few years, it is true—more true than most engineers are willing to admit.

Since it is true that engineering graduates are weak in English, there are three classes of people who should be interested in the fact; teachers of English, teachers of Engineering, and the students and graduates themselves. It is indeed high time that we should be putting our heads together and asking ourselves some pertinent questions. Why, we should demand, is this so? What is the reason for this poor English? Who is to blame? Why is there a need for engineers to know good English? If engineers write poor English when they ought to be writing good English, is there any remedy? The purpose of this paper is not to furnish a condensed manual of Engineering English, it is not a tabloid version for the guidance of would-be writers. It is merely an attempt to answer the above questions.

*Department of English, Oklahoma Agricultural and Mechanical College, Stillwater, Okla.

Who is responsible for the bad English of our [illegible] neers? Who is the guilty party? Ask a member [illegible] Engineering faculty and he tells you unblushingly [illegible] the department of English is responsible. Ask an [illegible] lish instructor and you are told that the reason [illegible] to a lack of coöperation from the engineers. Get [illegible] men together and they solemnly assure you that the [illegible] misguided student is to blame. The real truth of [illegible] matter is that all three are severally and collectively [illegible] blame.

Many of our preparatory schools send students to [illegible] lege without having given them sufficient training in [illegible] fundamentals. For this the student must suffer. [illegible] teacher too, for he is then compelled to spend valuable time in correcting errors that ought to be spent in thought building and the more advanced phases of the subject. Some of these students are so weak that they never get a chance to grow strong. Other students enter college from good high schools with a strong groundwork in English. They think they know all about such stuff. They come to college to study "Engineering" and look with disgust upon any subject that has nothing practical about it. "English is all right for girls and liberal-arts students, but what do we care about it? We want things that are technical, that will help us in our chosen profession, that will give us bread and butter." Thus these would-be engineers reason, and in their ignorance they refuse to accept English as part of their regular work. Instead, they neglect it, ridicule it and do just as little work as they can. Their whole aim is to get a passing grade. Once free of the English department, they shun it ever after. It is only when they get out in the world that they realize their mistake. This is how the student is to blame.

The teacher of English is to blame, first of all, because he does not realize and understand the average undergraduate's idea of English and change it. Too many times the teacher is not in sympathy with his engineering students and makes no attempt to be so. He looks upon his students as a lot of rough, uncultured sort of fellows, who need to be given all the refinement and culture possible in his course because it is the only chance they have. All the rest of their studies are brutally practical. He outlines his course accordingly and gives them the work that he imagines will give them the most of this culture. Many times this teacher knows nothing at all of engineering things and makes no attempt to know. The whole English department sometimes looks upon the engineers as its greatest burden—to be avoided if possible. As a result, the teaching of these students is shunted off onto the new or the incompetent instructors.

The Engineering instructors have only themselves to blame when they say that the student has not had a thorough training in English. The reason is that there has often not been time enough to train the students. In many schools there is only one year of English; in most others, two. The student is thrust into technical work entirely and does no more work under the supervision of the English department. His English instructor may never see a specimen of his work during the last two or three years of his college career. If the Engineering instructors did their duty, there might be no necessity for his seeing the work. The fact is, however, that the Engineering instructor does not do his work He does not hold his students up to the requirements set

the English department. Ask the Engineering men how many of them hold a student responsible for good spelling in his technical reports and nine out of every ten will say they do not. The Engineering instructor is to blame then for not carrying into the student's work, the precepts taught him in English.

In not backing up the English instructor, the Engineering instructor makes himself liable to the most serious charge against him. He fails to realize that there must be coöperation with the English department if any results worth considering are to be produced. He fails to realize that his acceptance of one report poorly written may undo the work of a whole semester in composition. If the student can palm off poor work, what is the use of working his head off re-writing sentences and looking up words in the dictionary? Example is always more forceful than precept.

The department of Engineering is at fault in not recognizing the value of English to the student and putting more of it into the curriculum. The reason given is, of course, that there is no room. Room must be made. Either some other subject must be dropped, or the time or the course must be lengthened. It is a problem to be solved and the engineers are to blame for not having solved it. No, rather they are to blame for not calling in the English instructor to help them solve it. Lack of coöperation is the greatest reason for poor English among engineers.

Engineers often give as their excuse for poor English that an engineer does not need to know how to write. Any man who makes such a statement is unfit to be called an engineer. Clear, definite, concise writing is, perhaps, the hardest to write, and yet this is the kind that the engineer is constantly called on to write. True, he does not have to write glowing descriptions of the sunset, nor does he have to work out essays on honesty. He does have to write letters of application, where his letter is put by the side of a dozen or a hundred others and his chance for the position depends upon his ability to state his case better than the other fellow. There are specifications to be submitted in competition, where the one that gets the award is the one that is expressed in the clearest manner. Contracts are to be drawn where one obscure clause may bring on a lawsuit. Reports must be made to superior officers that will bring promotion or discharge—depending entirely upon the work. That an engineer needs English is too obvious to be discussed more.

If Enginering students write poor English when there is need for them to write good English and we know rather well what is the reason for this, there ought to be some way of correcting the evil. There is. The first thing to do, in case the school is not strictly engineering, is to segregate the engineers into sections by themselves. No real results can ever be achieved by having a class composed of agricultural students and engineers, say. Put the engineers by themselves. Then get them teachers who know how to teach them. Give them teachers who teach nothing but engineers. At the University of Kansas there is what might be called a sub-department of Engineering English. This has entire charge of the English for engineers. At Tufts College, an engineering instructor must serve an apprenticeship of a year in the department before he is allowed to have a class of his own. The English instructor at the University of Pennsylvania who aspires to teach engineers must serve two years.

Have an English instructor of the proper training and ideals and life will give his students the kind of English that they need. He will inspire interest in them. They will be made to realize right at the start that English is a live subject, and that for them it is important. At least two of our great engineering schools begin the English course with a lecture on the Twentieth Century Engineer. The aim of the whole course is to turn out students in accord with this ideal. This teacher will not have his students writing about silos and Egyptian mummies when they want to be writing about bridges and induction coils, or about the sewerage system in their home town. His pupils will not come to class because they are required to attend so many times in order to pass. Coming to class will be a pleasure instead of a bore.

There are some students who, because of poor preparation or other reasons, will do poor work in spite of good teachers. Many of the big schools do not bother with this kind. They already have more of the good kind than they can handle. All poor ones are weeded out without mercy. In other schools everything possible is done to encourage and help the poor student. One of the best solutions of this problem comes from Northwestern University, where all such backward students are put in an extra class where, without credit, they must study spelling, grammar and punctuation. They must pass this course before they are given credit in the regular course.

For the ordinary student who passes his required work in English and then, once clear of it, fails to do good writing, there are two possible cures. One of the most effective ways is to give the engineering student a provisional grade in English. If at any time the student shows signs of weakness, change that grade to a condition or failure and make him take the work over again. Another plan is not to have any prescribed amount of English. Put the student in the English department and keep him there until the department is satisfied that he can write. This may take a year, or it may take four years. If at any time the student shows a relapse, put him back for more English. This is the system employed at the Massachusetts Institute of Technology. Either of these plans ought to remedy the evil of not giving enough time to the study of English.

Both of these systems require coöperation between English and Engineering. The men who teach the technical subject must be able to help the men who teach the composition. Each must back up the work done in the other department. Each must realize that the work of the other is important. The English instructor and the engineer must realize that their problem—that of turning out efficient engineers—is the same. The more they plan together, the more advice they get from each other, the sooner will they turn out the engineers who will not disgrace the institution that graduated them because of their inability to use clearly and forcefully their mother tongue.

Germany's Foreign Trade in Structural Steel—In the first six months of 1913 Germany exported 14,000 tons and imported 3 tons of bridges. In other structural-steel work it exported 47,000 tons and imported 700 tons. The aggregate represents an increase of about 12,000 tons, as compared with the first six months of 1912. ["Der Eisenbau," October, 1913.]

A Manufacturer's Hydraulic Laboratory

By P. A. Bancel*

The works of the Wheeler Condenser and Engineering Co., at Carteret, N. J., cover an area of about fifteen acres. The products of the company include surface and jet condensers of all sizes, centrifugal pumps, reciprocating and rotary air pumps of many different types, forced- and natural-draft cooling towers, engines, evaporators and multiple-effect and similar machinery for the chemical industries. The shops comprise a pattern shop, blacksmith shop, a large iron foundry, brass foundry, main machine shop, large erecting floor and a sheet-metal shop.

Some years ago the necessity of increased testing and experimental facilities became apparent. The design of high-vacuum condensers depended to a great extent on efficient air removal and it was necessary to know exactly the capacity and efficiency of different type and sizes of pumps when compressing highly rarefied air. Another problem in modern condenser design was that of high-speed low-head centrifugal circulating pumps, and "low-entrance head" hot-well and tail pumps. Therefore, a new test room was provided to give full facilities for the solution of all such problems, besides the regular commercial shop tests of standard apparatus.

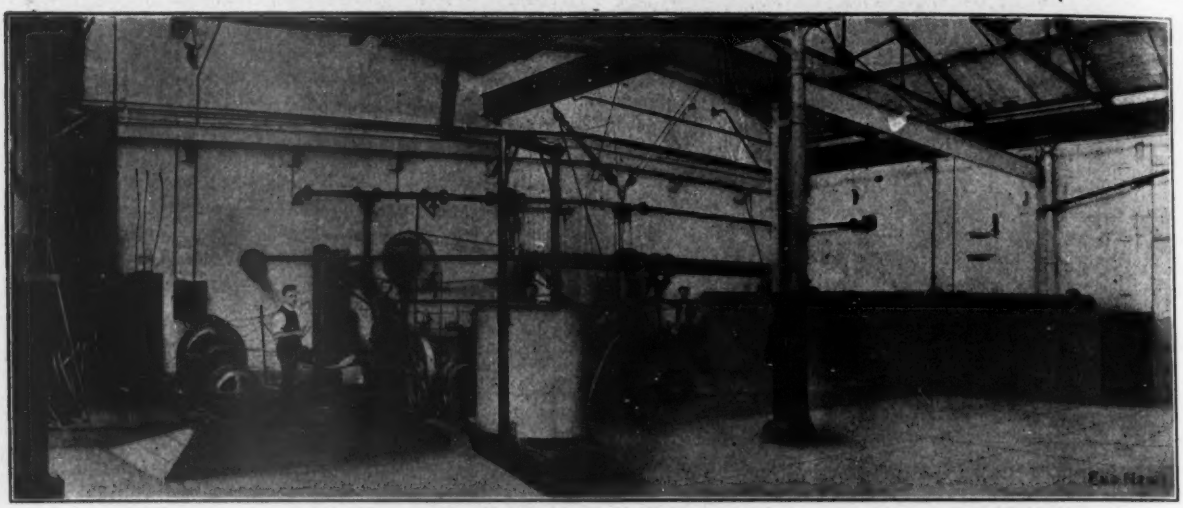


Fig. 1. General View of Hydraulic Laboratory at the Works of the Wheeler Condenser & Engineering Works, Carteret, N. J.

Equipment—The test floor (Fig. 1) is located just off the machine shop and occupies a space about 50x50 ft. The roof is saw tooth, the walls are white and the day lighting is exceptionally good, thus assuring accurate readings of gages and instruments. Large tungsten lamps furnish equivalent artificial illumination for night testing and for the darker hours in the winter. A seven-ton crane spans the test room and picks up the pumps from trucks, on which they are run in from the erecting shop, and sets them down upon the test block where desired.

The test block is a massive casting 24 ft. long, 14 ft. wide and 6 in. thick, carried by I-beams above a 50,000-gal. water tank. The block has longitudinal slots to [illegible] T-head bolts, which clamp machines in any posi[illegible]. Three holes are cut in the test block for suction p[illegible]; two are for 12-in. pipes and the third is a larger [illegible] for 26-in. pipe. The pipes have been permanently [illegible]stalled and connections to pumps are made by redu[illegible].

The test room is furnished with both steam and [illegible]tric power. Steam at pressures up to 200 lb. is obtained from the works boiler plant, which has been given increased capacity for the service. A steam header runs along the wall with various-sized flanged connections located at several points in its length, permitting of running a number of steam-driven machines at the same time. Exhaust steam is discharged to a permanent 50-ft. 10-in. exhaust pipe, erected outside of the test room. Electric power is supplied by variable-speed motors with switchboard and control apparatus. Two special variable-speed induction motors are shown in Fig. 2. The smaller machine is rated at 35 hp. and the larger one at 100 hp., both being good for 25% overload. They have a speed range from 600 to 1160 r.p.m., being regulated by controllers, very similar in appearance to the ordinary street-car type, which vary the resistance in the secondary circuit. The resistance grids are arranged in rows overhead. The switchboard in the corner has main-circuit switches for the motors and smaller switches for a wattmeter. The instrument used has a very open scale for the upper part of its range and by changing the switchboard transformer for different machines, the power reading may always be obtained on the open and accurate part of the scale. The motors have been calibrated and curves for efficiency at different speeds and powers are used in connection with the wattmeter and tachometer readings to give the actual shaft horse-power output under any load.

Pumps may be either directly connected to motors or belt driven. A special pulley block (Fig. 3) has been devised to expedite the work of connecting up pumps for belt drive. The head carries, in journal boxes on gibs, a shaft with a flexible coupling on one end, and a pulley in the middle, driven by a belt from the motor as shown in Fig. 3. The elevation of this shaft is adjustable by

*G. H. Gibson Co., Tribune Bldg., New York City.

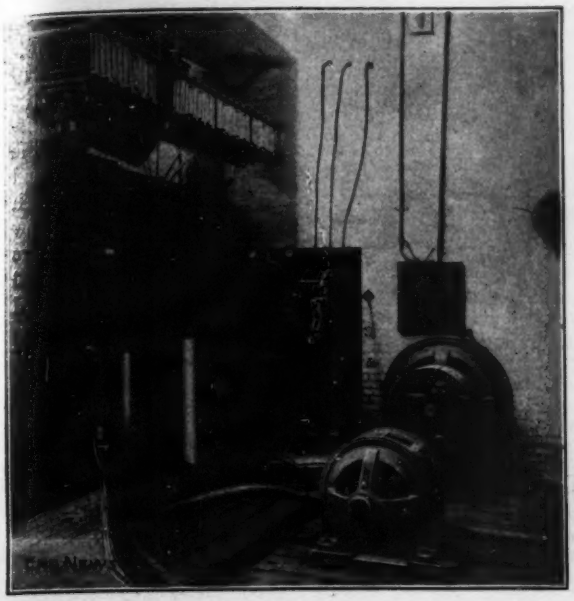


FIG. 2. CORNER OF TEST ROOM, SHOWING SWITCHBOARD, CONTROL APPARATUS AND TWO MOTORS

hand-wheels on lead screws working in the journal boxes; the center line of the shaft may be raised or lowered to bring it into line with the shaft of the pump for connecting the coupling.

WATER MEASUREMENTS—A large concrete weir tank is shown at the right in Fig. 1, and in Fig. 4. It is 29 ft. 8 in. long, 9 ft. 9 in. wide and 4 ft. 7 in. deep, with walls 8 in. thick. The water-supply for pump testing is drawn from a tank 24 ft. in diameter and 15 ft. deep (capacity about 50,000 gal.), located beneath the test block as already mentioned; this tank also serves as a sump for a forced-draft cooling tower operating in connection with the works condenser. Water, after passing through the pump under test, is discharged through a large permanent pipe to the rear of the weir tank. A wire screen and baffles prevent the water from rushing directly into the weir chamber of the tank. For accurate measurements of water flow by weirs, the approach chamber must be large and the water a few feet upstream from the weir must be at rest; these conditions have been secured.

For pumps below 250 gal. per min. capacity, a submerged rectangular weir is used, similar to that used in indicating hot wells; for pumps above 250 gal. per min. there is a V-notch wier having a capacity of 2500 gal. per min., and two V-notches in parallel for capacities up to 5000 gal. For capacities of 5000 and up, an open rectangular wier is used, this being inserted in the place of the two V-notches. With each wier the zero line remains the same, so that the same apparatus for reading head may be used in all cases. At present a hook gage is used but later there will also be installed a float recorder, reading directly in gallons per minute.

Accurate measurement of water pressure here is of equal importance to accurate measurement of quantity. With low-head pumps working on only 10 to 30 ft. total, use of the ordinary spring gage is out of the question; mercury columns have to be used exclusively on the suction and on the discharge. Here the column scales have been calibrated to read in pounds per square inch. One column used has a maximum reading of 60 in. of mercury, corresponding to about 30 lb. per sq.in. or 70 ft. of water. Mercury columns are, of course, also used for measuring vacuum and barometers for atmospheric pressure.

AIR MEASUREMENTS—The measurement of air by nozzles is customary in connection with tests of rotary air pumps and it was decided that this method would be used here for such service. But the accuracy of air measurements by orifices or nozzles is dependent upon the accuracy of certain equations and theoretical deductions, so that it was thought very important to have apparatus for calibrating the nozzles. For this purpose, a special gasometer was constructed for measuring the air discharged from dry-air pumps by actual volume. The gasometer may be seen in Fig. 1 as mounted on skids; it consists of two cylindrical tanks, one telescoping into the other and counterbalanced by weight and cable. Air is discharged into the inner bell above a water seal through a central discharge pipe and the rise of the bell indicates the volume of air entrapped. It is necessary only to read the temperature and pressure of the air entrapped, the

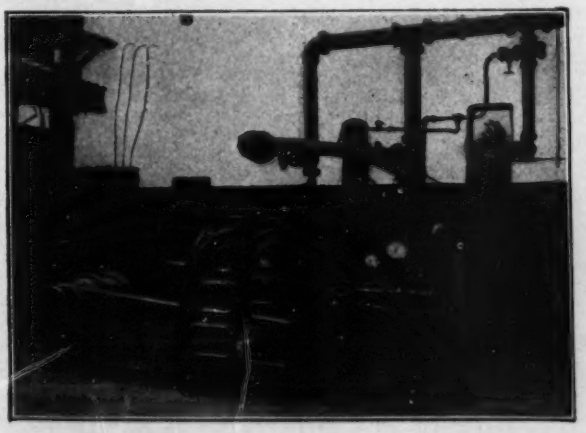


FIG. 3. A SINGLE-STAGE CENTRIFUGAL BOILER-FEED PUMP UNDER ROUTINE TEST
(Showing adjustable shaft frame.)

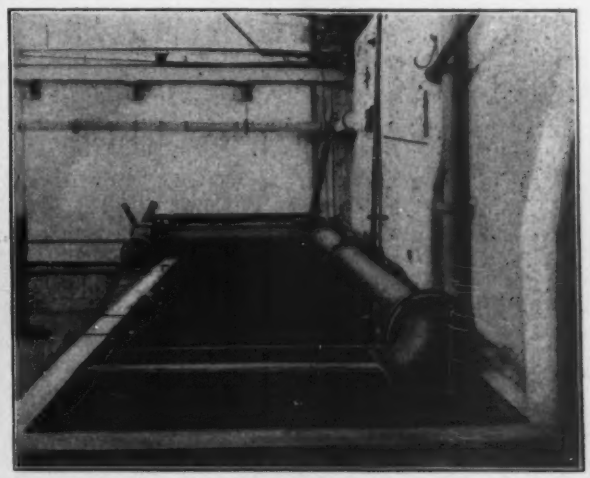


FIG. 4. WEIR TANK, FROM ABOVE REAR END

pressure differing by only a few inches of water from that of the atmosphere.

The nozzles were calibrated by use of the gasometer in the following manner. A dry-vacuum pump was set up with its suction connected to a manifold in which were located the different nozzles, any one of which could be opened by removing its cap. The discharge of the air pump was connected to the gasometer. Various runs were then made with different nozzles admitting air to the pump, readings being taken of the time required to fill the bell, the temperature and pressure of the air in the bell, the vacuum on the suction of the pump, the speed of the pump, etc. It was necessary to make a careful air-leakage test with all of the nozzles blanked off. The air leakage was found to amount to a fraction of a cubic foot per minute at the high vacuum (29½ in.) maintained by the pump when it was handling no outside air. A proper correction was made for leakage air when calculating the actual volume of air delivered by the different nozzles.

Unexpected results were obtained in the nozzle-calibrating tests. The figures show a considerable inaccuracy in the widely accepted formula for the flow of air through bell-mouthed orifices. This formula assumes that the velocity of air through a nozzle is equal to the velocity of sound in air at the same temperature and pressure. These tests demonstrated that the velocity was only about 65% of such a value.

This case of the nozzles is cited to emphasize the necessity of adequate testing and experimental equipment in the design of condensing apparatus. The tests of air capacity have formed the basis for the proper rating of all types of air pumps and a rational selection of the proper type for any particular service. Other important experimental work already completed in this laboratory is the development of two different types of high-speed centrifugal pumps for large capacity and low head. This original work in the test room has been done without appreciable interference with the routine work. All circulating, tail-water, condensate, turbo-air, dry-air pumps, etc., are tested for capacity, efficiency and smoothness of operation, before shipment.

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Studies of River Bottoms at Philadelphia in Relation to Sewage Disposal

Studies of the condition of the bottoms of the Delaware and Schuylkill Rivers at Philadelphia have been made by the Bureau of Surveys of that city. The studies were a part of extensive investigations preparatory to submitting a sewage-disposal plan to the State Department of Health. A paper describing these river studies was read to the Sanitary Engineering Section of the American Public Health Association, at Colorado Springs, Colo., in September, 1913, by W. L. Stevenson, assistant engineer, Sewage Disposal, Bureau of Surveys, Philadelphia. The accompanying illustrations, Figs. 1 and 2, show the location of the sampling points and the character of the deposit on the main bottoms (where any was found).

The location of Philadelphia in relation to the two rivers and tributary streams is shown by Fig. 1. The Delaware River has a channel depth of about 30 ft., a tidal range of about 5½ ft., a normal runoff above Philadelphia estimated at 4050 sec.-ft., and a total tidal flow [illegible] the city of 2,421,000,000 cu.ft. in a period of 7 hr [illegible] min. The Schuylkill River has a normal flow of [illegible] sec.-ft. A dam about midway of its length within [illegible] city forms a pool in the river. Combined sewers [illegible] charge into the rivers and creeks, except that above [illegible] dam just mentioned the sanitary sewage is intercep[illegible] and conveyed to a point below the dam, in the tidal re[illegible] of the Schuylkill. This part of the river has a very l[illegible] velocity. In extreme dry weather almost no water flo[illegible] over the dam to afford dilution to the sewage of 450,0[illegible] people which is discharged below the dam. Frankfo[illegible] Creek has pools on its length within the city and r[illegible] ceives the sewage of about 740,000 people. The beds [illegible]

FIG. 1. MAP SHOWING LOCATION OF SAMPLING POINTS IN RIVER CONDITION STUDIES AT PHILADELPHIA

the lower Schuylkill and of Frankford Creek contain sewage deposits, those near the mouth of the river being several feet thick. The putrefaction and decomposition of these deposits cause liquefaction of the organic matters and the liberation of gases. The sewers which discharge into the Delaware have their outlets at the bulkhead line, for the most part, where the velocities are low, and deposits occur. Altogether, the Delaware, either directly or through its tributaries, receives the sewage from 1,600,000 people, "which has been subjected to a crude form of natural sedimentation in the creeks, Lower Schuylkill and docks." The effect of sedimentation, which tends to make such suspended matters as reach the channel finely divided in character, and the high stream velocities, keep the bed of the Delaware, "except in the docks near sewer outlets, practically free from deposits of sewage origin."

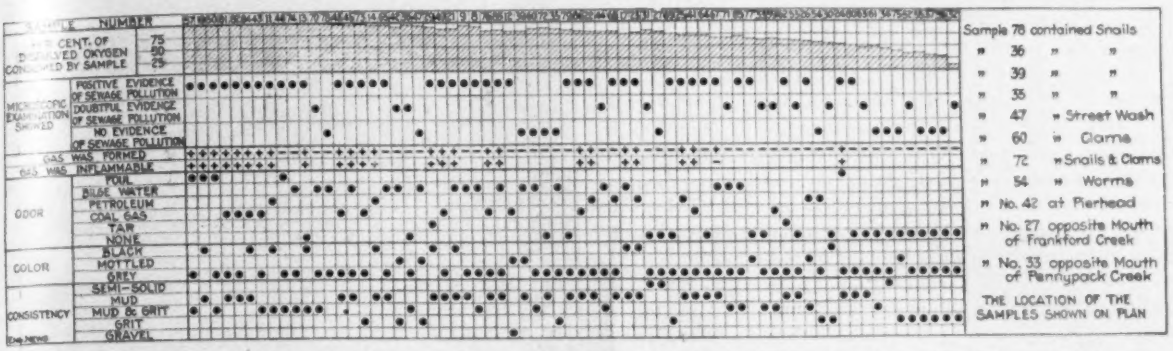


FIG. 2. RESULT OF EXAMINATION OF SAMPLES OF DEPOSITS ON THE BOTTOM OF THE DELAWARE AND SCHUYLKILL RIVERS, PHILADELPHIA

The field and laboratory methods used in these studies were described by Mr. Stevenson as follows:

FIELD METHODS—The samples of the river bottom were obtained from a boat whose location was determined at the time of sampling by sextant observations of known locations on shore.

Several types of apparatus were tried in order to obtain samples, even when the deposit was hard and of only a thin layer. The form finally adopted consisted of a heavy galvanized cylinder, 6 in. in diameter and 9 in. long. The top had a hinged cover capable of being raised only and with a rubber gasket seat, so that when the apparatus was hauled up the sample would not be washed out. To the lower part of the cylinder was soldered a galvanized-iron cone in which lead was poured to weight the point. About where the cone joined the cylinder were four round holes 1 in. in diameter and provided on the inside with hinged valves only capable of opening inward.

When this apparatus was lowered to the bottom it sunk in the deposit, which was admitted to the inside through the four small holes. It was then moved up and down a few times to cause it to fill more completely. The valves prevented the deposit from flowing out or water flowing in while it was hauled to the boat. The supernatant water was poured off and a pint jar filled with the deposit, its characteristic noted, such as "sandy," "foul odor," thin mud," etc.

LABORATORY METHODS—The samples were not examined in the laboratory until the following day. When the jars were opened the odor was noted. If gas had accumulated in the top of the jar it was tested with a flame to see if it would burn, and, if not, again tried while the contents of the jar were being stirred. Fifty cubic centimeters of the deposit was placed in a pint jar, which was filled with aërated tap water. This was kept at room temperature for about five days, when the amount of dissolved oxygen consumed by the deposit was determined, to show the putrescibility or stability of the sample.

The sample in the original jar was emptied into a sand seive having 20 meshes per inch, which was then alternately moved up and down in a flat cylindrical glass vessel containing clean water. This washed the finely divided mud through the seive. The operation was completed by using fresh water until the débris in the seive was freed from mud.

In undoubtedly polluted samples the microscopist had no trouble in at once fishing out characteristic débris of sewage origin. From samples not grossly polluted the débris was fished out of the screen and cleared up in 10% hydrochloric acid, then mounted in glycerin and examined under the microscope.

Permanent mounts were made of various materials, such as fiber from linen, silk, wood, vegetables and different kinds of meats. To these were added known objects recovered from the samples. These served as standards for the identification of unknown objects obtained from the river bottom.

A study of the results of the examinations of mud (Fig. 2) in connection with their points of origin, shows how closely the two correspond. There were some cases where microscopical and chemical tests did not agree, showing, in the opinion of Mr. Stevenson, "that fair conclusions can only be drawn from the [microscopical] observations, and a determination of the putrescibility of the sample as measured by its power of deoxygenating water."

In conclusion, the author makes acknowledgments to the following officials and employees of the Bureau of Surveys: Geo. S. Webster, chief engineer; George E. Datesman, principal assistant engineer; Wm. B. Erichson, who had charge of the field work and chemical examinations in the laboratory; and to Dr. Carl Stienke and Dr. J. Douglas Blackwood, who made the microscopical examinations. Acknowledgment is also made to Geo. A. Soper, President of the Metropolitan Sewerage Commission, New York City.

The Exhaustion of Anthracite Coal Deposits in Pennsylvania will be reached in 81 years according to M. S. Hachita, Chemist of the Lehigh Valley Coal Co., in a recent speech before the New York and Western Pennsylvania Coal Merchants Association. To substantiate this claim, Mr. Hachita quoted several authorities. The Geological Survey of Pennsylvania states that there were originally approximately 19.5 billion long tons of anthracite in the ground in that state. Assuming 40% as the quantity possible of extraction, 7.8 billion tons is then the initial available supply. Since 1820 nearly 2 billion tons have been mined, which would leave nearly 6 billion available. T. S. Harris in the "Forum" estimated that there were something like 14.45 billion tons originally in the ground, making, by the same process of calculation, about 4.8 billion available. According to A. D. W. Smith, about 5.56 billion tons still remain to be mined. In 1896, William Griffith made an estimate from which it is computed that about 4 billion available tons remain in the ground.

The average of these four expert estimates show that there are still 5.07 billion tons of coal possible of being mined. The average annual production for the past 10 years has been 62,817,910 tons; at this rate the available supply would last 81 years; but the present year's production would reach 70,000,000 tons.

Completion, Testing and Dedication of the Los Angeles Aqueduct

By Burt A. Heinly*

After eight years of labor, during which time an army of from 2500 to 4000 men have been continuously employed either in the Mojave Desert, or along the ranges of mountains which fringe it, the municipality of Los Angeles set Wednesday of the current week (Nov. 5) for the formal dedication of the Los Angeles Aqueduct as a completed work. Tests of the various sections of the aqueduct which have been going on continuously since Sept. 24 and which were terminated on Oct. 16 by the issuance of the water of the Owens River through the outlet gates of the aqueduct in the San Fernando Valley have confirmed all the claims made by the engineers who have been in charge of the construction. The 233 miles of canal, conduit, tunnels, steel and concrete siphons which make this water-works system in many respects the most remarkable of its kind in existence, today await the use for which they were designed.†

The place chosen for the dedication ceremonies is at the outlet of the aqueduct, 25 miles northwest of the city. The site is one of great natural beauty, with a setting of low mountains surrounding it on three sides. At this point the aqueduct is brought by a 1600-ft. tunnel through a spur of the Santa Susana Range to emerge at the summit of a high projecting ridge. A substantial concrete structure of most simple design (Figs. 2 and 3) set into the mountain side masks the tunnel portal. Two 4x5-ft. sluice gates operated by hand regulate the flow.

From this portal an open concrete-lined conduit is carried down the summit of the ridge, a distance of 1036 ft. A fall of 167 ft. provides opportunity for a cascade effect which has been heightened by emplanting large and small boulders at random in the bottom of the conduit (Figs. 4 and 5). While the utilitarian value of this in thoroughly aërating the water is an important one, the purpose of the design is mainly æsthetic.

It is at the foot of the cascade that the speaker's stand was erected and a broad space cleared for the audience. The program provided that William Mulholland, chief engineer of the project, should present the work to the city, and that the response of acceptance should be made by Mayor H. H. Rose. Following this the construction of the San Fernando Dam by the sluicing process was to be open to inspection, and the city's guests to the number of three hundred were to be entertained at a barbecue typical of the days of southern California under the Spanish regime. A reception at the Chamber of Commerce was to follow in the evening.

The program for the second day of the celebration (Nov. 6) provided for a parade of the city's industries, and at Exposition or Agricultural Park, the laying of the cornerstone of the State Armory and the dedication of the Aqueduct Memorial site.

The Aqueduct Memorial (Fig. 1) is designed to typify the coming of the waters and is to be built by popular subscription with possibly municipal assistance later when finances will permit. The fountain is planned as the contribution of Los Angeles to California's activity in the World's Fair Year of 1915, and if the accepted designs as prepared by Mr. G. A. Howard, the architect, are followed to completion, the monumental structure will be in accord with the great work which it commemorates. In brief, the fountain, or monument, to be surmounted by the figure of a young woman, typifying the municipality of Los Angeles, will consist of a Doric column 265 ft. high and 35 ft. in diameter. Down the sides of the column will flow Owens River water with a fountain effect. The base of the fountain is to be an art gallery 110 ft. square and 30 ft. high, the exterior walls to carry in enduring relief and natural colors, on panels 100 ft. long and 12 ft. high, descriptive scenes of the city's conflict with the desert in the construction of her new water-works. The original plans call for concrete faced with glazed tile, the estimated cost complete to be $500,000, but there is a movement on foot to use California marble as the building material, which would largely increase the amount now set.

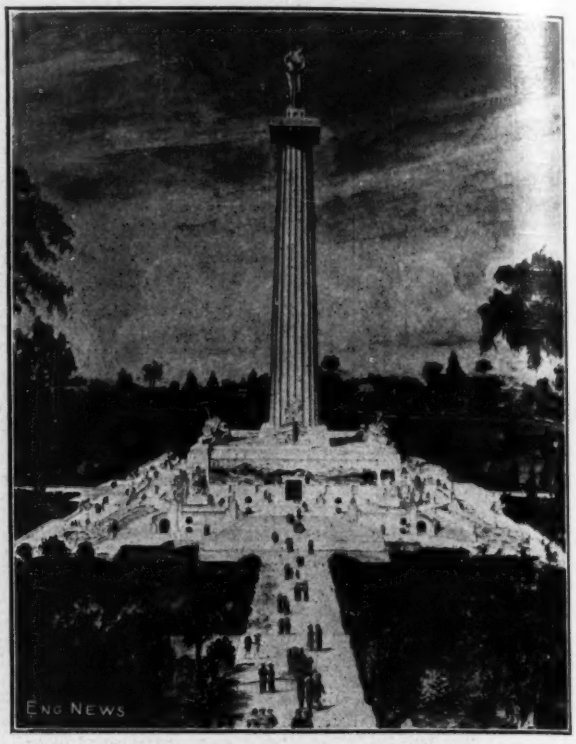


Fig. 1. Proposed Aqueduct Memorial, Los Angeles, Calif.

As originally planned, the dedication of the aqueduct was to have taken place on June 18-19 of this year, but in the testing of the Sand Cañon siphon, 175 miles north of Los Angeles, on May 19, the work failed through the saturation and slippage of the rock in which the pressure tunnel was constructed (see Eng. News, May 29 and June 5, 1913). This was the only inverted siphon in pressure tunnel on the aqueduct, and immediately upon its failure, a siphon of all steel construction (Fig. 6) in every respect similar to the other inverted steel siphons of the system, was determined upon. The siphon as rebuilt on a new site comprises 2552 ft. of pipe, ¼, ⅝ and $\frac{11}{16}$ in.. in thickness of shell and from 8½ to 10 ft.

*636 South Hill St., Los Angeles, Calif.

†The aqueduct was described and illustrated in a long article by the author in "Engineering News" of June 19, 1913.

in diameter. The material, with the exception of 890 ft. of 4½-ft. pipe used in the rock tunnel siphon, was obtained from an Eastern foundry, and the whole work was completed and ready for testing on Sept. 24, or 123 days following the destruction of the siphon which it replaced. Despite the large amount of work necessary to clear the cañon walls to a firm foundation, the record established for fast and thorough work surpassed any of the previous records that had been made on the aqueduct in the line of steel laying. All the work was done by day labor under the direction of the city's engineers, and every assistance possible was given for hastening the job. The siphon, on testing, proved tight and satisfactory in every way. The construction was driven forward under conditions of desert temperature that reached on one occasion as high as 124° F.

The testing of the siphon was undertaken on Sept. 19 when 3½ sec.-ft. was allowed to enter from the Haiwee Reservoir. On Sept. 23 this was increased to 10 sec.-ft. and from that slowly up to 87 sec.-ft., the chief engineer and his assistants then following the water southward as it traveled at a rate of from two to four miles an hour. It should be stated that the first 68 miles of the aqueduct have been in operation since Feb. 12, and that the Haiwee Reservoir, with the exception of an interval of the past two months, devoted to cleaning the canal, has been in process of filling.

On Sept. 27, at 7:30 p.m., the water of the Owens River reached the Fairmont Reservoir, a regulating basin of 7620 acre-ft. capacity governing the flow through the five-mile Elizabeth tunnel, situated on the northern edge of the Coast Range, 198 miles from the intake and 35 miles from the outlet of the aqueduct. Three days were required for the filling of this reservoir to a point where the water level was at an elevation sufficient for maintaining a flow through the Elizabeth tunnel. On the morning of Oct. 1, Mayor H. H. Rose, in the presence of a number of aqueduct engineers and various other city officials, turned the lever which lifted the gates sufficiently to permit of a passage of 15 sec.-ft. After passing out of the southern portal of the tunnel (as the penstock of power house No. 1 and about 2000 ft. of power-pressure tunnel are not completed), the water by a temporary diversion was turned into the natural channel of the San Francisequito Cañon. Seven miles below it was again diverted into the aqueduct, and on Oct. 2 the filling of the Dry Cañon Reservoir, a power-regulating basin of 1325 acre-feet, was begun. The flow was then gradually increased to 80 sec.-ft. Oct. 14, the water of Owens River entered upon the last 12 miles of its journey to the outlet of the system. This section of the aqueduct has been in operation for the past year and a half, a small pumping plant pumping from wells into the Soledad Cañon Siphon, the water then being taken out at the outlet of the aqueduct through a 14-in. sheet-steel pipe and carried three miles to the San Fernando Dam, where it was used for sluicing purposes. On the morning of Oct. 16, the outlet gates were opened and a flow of 15,000 miners' inches was permitted to play for several hours over the cascade pre-

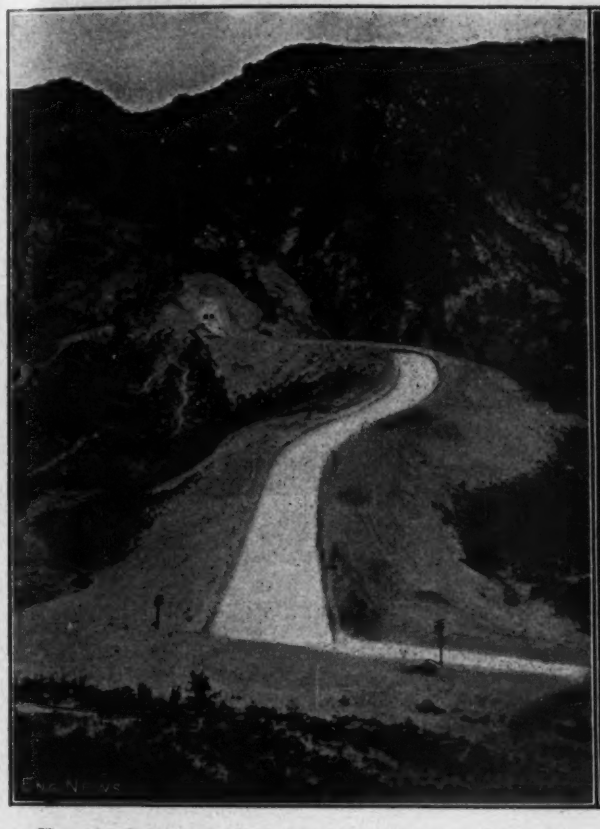


FIG. 2. GENERAL VIEW OF OUTLET AND CASCADE

FIG. 3. VIEW OF OUTLET GATES

viously described. Thus was completed the initial operation of the works.

In addition to these tests, nature herself severely tested the work during September. In this month the Southwest was visited by a severe and unusual heat wave which in the mountain region facing on the desert was accompanied by cloudbursts of unprecedented violence. One of these occurred in the Tehachapi Mountains, where in Tehachapi Pass it carried out the main line of the South-

Angeles the electric power generated by the heavy f n the lower part of the aqueduct.

Irrigators throughout the San Fernando Valle d between the Santa Monica Mountains and the sea d ready to take the water, or much of it, but the terms r which contracts can be made or the water obtaine e yet to be stated. The Board of Public Service Co s- sioners with its reorganization since July 1 unde e administration of the new mayor, H. H. Rose, has p d

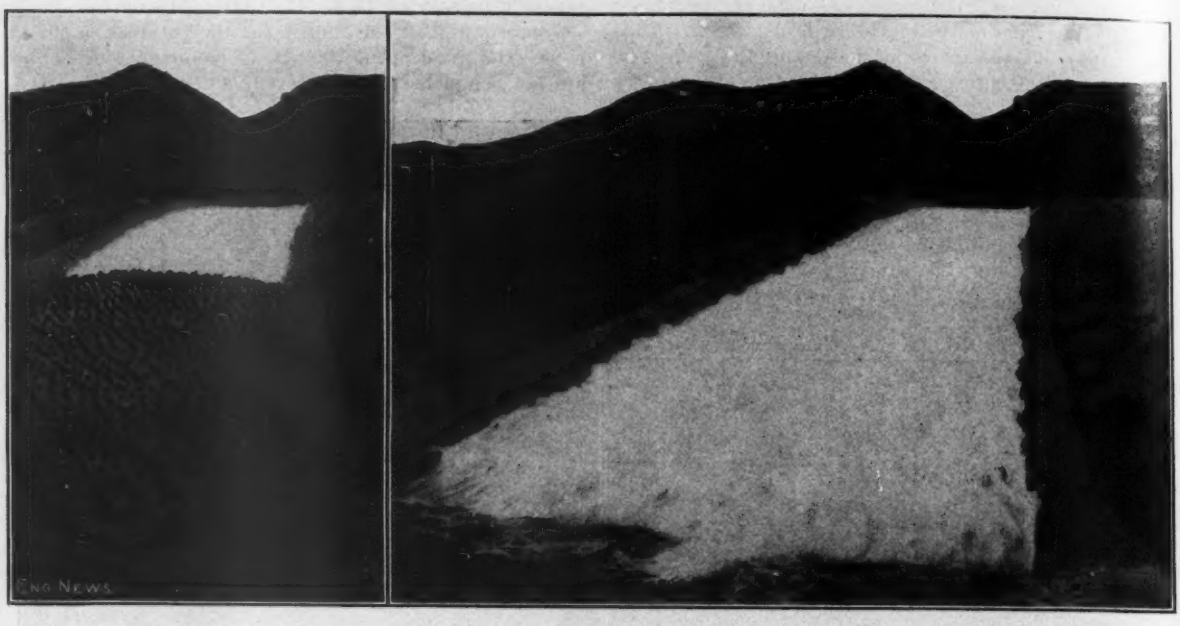


FIG. 4. FIG. 5.

FIG. 4. SHOWING BOULDERS TO GIVE CASCADE EFFECT. FIG. 5. LOWER PART OF CASCADE.
THE OUTLET PORTAL OF THE LOS ANGELES AQUEDUCT AND THE CASCADE.

(The original of the general view is copyrighted by the Bledsoe Photo Co. Parts of the original at the right and left are not included in the view.)

ern Pacific R.R. for four or five miles. Continuing on down, heavily laden with débris, the avalanche of water reached a covered conduit section of the aqueduct and piled it high with sand and boulders. In one place the cover was broken for a distance of several hundred feet, but at all other points the work well showed the character of materials and craftsmanship.

While the actual capacity of the aqueduct is still to be determined by calibration of all the various sections, the studies that have so far been made go far to prove that the estimate of a net delivery of 20,000 miners' inches was too conservative on the one hand and that the allowance of 1550 miners' inches for seepage losses was too extensive on the other. It is confidently expected that final measurements will show an actual delivery capacity approaching 25,000 miners' inches, with the city's water holdings in the Owens Valley capable of delivering this amount.

The effect of the delivery of the water into the San Fernando Valley will impress the people of Los Angeles and vicinity with the fact that although the aqueduct has been successfully built, funds have not yet been provided to utilize the immense surplus of 18,000 miners' inches (of southern California), or 90% of the aqueduct flow, nor to complete the power plant and carry to Los

resolutions naming a rate of 1c. per in. per hr. for irrigation purposes outside the city limits, the works to be installed at the cost of the districts benefited. This rate amounts to 1.86c. per 1000 gal., and makes the annual cost of irrigation of one acre aggregate about $11.68 per annum. Cursory attempts are being made on the part of the outside districts to form irrigation districts. This has been brought to at least a temporary halt awaiting the findings of a commission of nine members appo ted by Mayor Rose to report upon the disposal of the water to outside territory as relating to annexation or consolidation with the city.

This committee, on Saturday, Oct. 19, stated unofficially that it was unanimous on the following propositions which make annexation the first requisite to the use of the water:

That annexed territory should bear its proportionate share of the aqueduct, power and harbor bonds, but not of the balance of outstanding indebtedness of the city.

That annexed territory should have local boards of public works to pass upon questions relating to streets and local public works and oversee such work, all under the direction of the city's board of public works.

That annexed territory should form agricultural sections and have one-half of the annual taxes it pays for the general running expense of the city set aside to constitute a road fund for general road work in those sections.

That extensions of light and power systems shall be

FIG. 6. RECONSTRUCTING THE SAND CANYON SIPHON, LOS ANGELES AQUEDUCT

(The original inclined pressure tunnel failed during test on May 19, 1913; the substituted steel conduit was completed on Sept. 24, 1913.)

made in annexed territory on the same general plan as may be followed within the present city boundaries.

That annexed territory may have the right to connect with the city's sewer system.

Whatever the outcome, the actual delivery of the water must galvanize the city authorities into some practical and feasible plan of *immediate* action (three years now having elapsed since it was first attempted) for the writer does not believe that the community will brook further delay in the matter.

The electors on Nov. 18 will vote on an issue of $6,500,000, of which $1,500,000 is to be devoted to the completion of power plant No. 1 and transmission lines to the city limits, with the remaining $5,000,000 to be used for the construction of a distribution system. The visualizing of the great natural wealth the city has in the aqueduct and of the fact that the power development must lie idle unless money is appropriated to complete the work, must have a helpful effect on the vote. This same bond issue, while it received a plurality vote of 30,615 to 20,800 in the election of Apr. 13, 1913, lacked the two-thirds vote required for its authorization.

Suggested Changes in Chicago Railway Terminals*

The need for a general change in the facilities now used in the passenger and freight business of most of the railways of Chicago is apparent to the most casual observer. The traffic of the railways is constantly outgrowing their facilities for carrying on the business. Likewise the traffic of the city has outgrown the capacity of the streets in the central business district, both as to the use of the sidewalks and of the roadways.

The business district of the city, represented by the area on the South Side, north of 12th St., substantially one mile square, is not only hemmed in on all sides by the railways, but is penetrated for about one-half of this distance by railway extensions inwardly from the south, so that the area free from railway occupation is limited to the central district, north of Van Buren St., and is in effect about one-quarter of a square mile.

Within this restricted area lie the active centers of the financial district, the retail district, the wholesale district, the public buildings of the National Government and of the city and county, the principal hotels and the great office buildings that centralize the commercial activities of the city. Within this narrow district the surface traction lines and the elevated railways of the city focus their entire traffic.

As a result of this varied and intense concentration of business activity, within an area representing 1/234th of the total area of the city, an undue congestion of the streets has been brought about during the business hours of the day—a condition so urgently demanding relief that immediate action toward that end is of vital importance.

Of the various plans that have been suggested for Union Station Passenger Terminals, none would eventually so effectually bar the expansion of the business district of the city southward as the proposal to locate such terminals at 12th St., occupying all the space between State St. and the river. The outlet for expansion of the business district southward of 12th St. should be kept open between Michigan Ave. and the river to the utmost extent possible.

Looking now to the West Side, we find that from 12th St. north to Madison St. the railways are limited to a narrow strip of land lying between Canal St. and the river, with tracks so much below the grade of the city streets as not to interfere with all the east and west streets being carried over the railway property on viaducts the full width of the streets, and of easy grades. It may therefore be proper to leave this railway strip to such intensive development as the railways deem advantageous to make.

From Canal St. westward to Western Ave., a distance of 2½ miles, and from 12th St. northward to Madison St., a distance of one mile, the West Side of the city has an area of 2½ square miles free from railway tracks, which offers great opportunity for industrial and commercial development.

To the northward the railways are substantially confined to a strip along the river and its north branch, leaving for

*Extract from a report by John F. Wallace to the Committee on Railway Terminals of the City Council of Chicago, Oct. 20, 1913.

business development on the North Side an area extending from Kinzie St. to North Ave., 1½ miles, and from the river to the lake, 1½ miles, equaling 2.25 square miles.

As a result of a study of existing conditions, it is self-evident that the principal thoroughfares connecting the central district with the north, south and west sides of the city should remain open and unobstructed, and provision be made for the widening of the more important ones as future necessities may require.

There are at the present time six railway passenger terminals in the city; namely, the North Western Station, the Union Station, the La Salle Street Station, the Grand Central Station, the Dearborn Station and the Central Station.

The North Western Station occupies the entire block between Canal St. and Clinton St. It has a width of 320 ft., and its length, including head house and train shed, is 1124 ft. The station was opened for service June 4, 1911; it has capacity for a large increase over the business now being handled; its cost was $25,000,000, and it should adequately meet the requirements of traffic for many years.

Of the five older terminal passenger stations now in use, three, the Union Station, the Illinois Central Station and the Dearborn Station, have served their purpose, and must soon be replaced with more commodious structures.

The La Salle Street Station, by the growth of business, will require enlargement or replacement within the next ten years.

The Grand Central Station, while admirably arranged, is badly located, with a drawbridge across the Chicago River, near its train entrance. It is of small capacity. The interests now owning this station might find it profitable to have the railroads using it secure facilities elsewhere, and dispose of this property for commercial use.

The Union Station Co. has submitted plans for a greatly enlarged passenger terminal located on Canal St., upon substantially the same site as to train shed and tracks that it now occupies.

The Illinois Central, owning the Central Station, has plans in course of preparation for a new and greatly enlarged passenger terminal, located at 12th St. and the Lake Front, with a possible capacity, on two levels, for taking care of all the railroads on the South Side of the city, now using stations east of the Chicago River.

Measured by the needs of the community alone, at least two general locations for railway passenger terminals are necessary to meet present requirements. One on the South Side and the other on the West Side, between Van Buren and Madison Sts. adjacent to Canal St.

It should be remembered, however, that the railroads now occupying other sites have vested rights in the present holdings and cannot be forced, without their consent, to remove or rebuild their existing terminals; and only their inability to take care of their expanding business or an opportunity to increase their revenue or reduce their operating expenses would probably induce them to abandon their present locations.

The Illinois Central having signified its willingness to make provision, on reasonable terms, in its new station for the passenger service of all the South Side roads, and with its main lines extending south and west to readily intercept the traffic of these roads, there appears to be no substantial reason why the grouping of the passenger terminals of the South Side lines at 12th St. and the lake front is not only feasible and practicable, but in every way advantageous to the railways, to the city, and to the community in general.

The elimination in the course of time of three of the existing passenger terminals—the Dearborn, the La Salle and the Grand Central—would dispense with unnecessary stations and simplify the railroad situation within the business district.

With two permanent centers for the development of the railway passenger terminals of the city thus established; the one at 12th St. and the lake front, and the one at approximately Canal and Madison Sts., the distance between these terminals would be approximately one mile east and west, and one mile north and south; the location of the North terminal being the northwest corner and of the South terminal at the southeast corner of a square mile, within which would lie the central business district of the city.

To ultimately complete the system of passenger inter-communication between the railways, and to make their terminals conveniently accessible from the outlying portions of the city and suburbs, a connecting railway system could be provided of dimensions sufficient to permit the movement of standard railway passenger equipment directly between the terminal stations, with surface outlets suitably arranged at convenient points for rail connection with the tracks of the terminal stations. Such direct physical connection to provide for the expeditious interchange of passengers, mail, baggage, express and sleeping cars between the different ro[illegible] and when necessary, the movement of complete passeng[illegible]ains from one road to another on opposite side of the ci[illegible]ith-out the delays incident to the present circuitous m[illegible] of making interchange over the surface tracks used by [illegible]rail-ways for freight, switching and passenger traffic.

A further use of such an inner circle of commu[illegible]tion between the railway terminals could be the extension [illegible] the suburban train service of all the roads of the city to [illegible]lude the circuit of the terminal stations and of the busin[illegible] dis-trict, thus putting every part of the city and its sub[illegible]s in direct connection with every railway radiating from t[illegible]city.

Considering the fact that as a condition precedent [illegible] the creation of any Union Station plan the concurrence of [illegible] the railroads using it must be secured in addition to the c[illegible]sent of the City Council of Chicago, and considering further that a large number of the railroads interested would be re[illegible]ired to give up situations which they independently contr[illegible] and which are considered preferential situations, also considering their legal rights; it would seem impracticable to bring about any joint harmonious action, in the near future, on any single Union Station plan, even though it might be a desirable one of itself. Ultimate accomplishment along these lines would be a matter of years of negotiation and perhaps litigation.

Heretofore in most of the large cities of the United States, few railroad terminal stations have been adequate for the necessities of the public and the railroads for a period of 25 years and we have no assurance that the new large stations now being planned and constructed, or those recently built, will show any better record than that indicated by the past.

A large Union Station located south of 12th St. between State St. and the river, even if the river could be straightened, which could not be brought about except after years of negotiation and litigation, would in a few years probably become congested, and the problem of enlargement be one of difficulty, inconvenience and expense.

It would also be an obstacle to future growth and development of the city southward, probably much more so than that now caused by the railroad holdings north of 12th St. It is less than fifty years since 22d St. was the southern limit of the city.

In the event of any or all of the South Side group of railroads not being able, for reasons of policy or for any cause, to utilize the Lake Front terminal south of 12th St. any new station facilities should be confined within street building lines with either subway or elevated approaches, in such a way as to avoid blocking or interfering with streets or thoroughfares, even if separate stations for different groups of railroads were rendered necessary; but it should be the policy of the city to enlarge, widen or extend its streets and thoroughfares leading to the southward and not to permit further encroachment thereon.

While the writer does not desire to burden this report with long arguments of a technical nature as to the question of the comparative advantages or disadvantages of a Central Union Station for all Chicago railways, as against independent stations or separate groups of stations situated around the business center, he does desire to state that he cannot see the advantage of the former either in convenience to the public or in economy or convenience of operation to the railroads; in fact, experience in other localities would seem to show, as far as the railroads are concerned, an increase in fixed charges and expenses of operation entirely out of proportion to any material advantages gained thereby.

I cannot see how a single Union Station, or a continuous group of adjoining stations lined up south of 12th St., could be convenient to that large part of the traveling public—be they through, local, or suburban passengers—which desires access to the business center of Chicago. If the present suburban stations are maintained, there is still less reason for a single Union Station south of 12th St. Nor can I see where or how such a station would relieve the present situation unless the suburban passenger business was provided for in some manner at least as satisfactory if not more so than at present.

From a practical railroad point of view, a single Union Station would increase congestion, be more unsatisfactory and inconvenient to passengers, and more expensive to the railroad companies, without enough compensating features to justify its use.

It is my recommendation that an ordinance for a Union Passenger Terminal at the location proposed by the Union Station Co., be granted.

The granting of the Union Station ordinance, however, does not insure the construction of the passenger terminal, for the reason that the site of the proposed passenger terminal overlaps the freight facilities of the Pennsylvania, the Burlington and the Alton roads.

To meet, in part, this situation, the Pennsylvania Co. has

submitted an ordinance granting to that company the rights and privileges necessary for the construction of a new freight terminal proposed to be located fronting north on West Van Buren St., covering the entire block between Jefferson and Desplaines Sts., and extending southward with buildings and train tracks to Taylor St.

The area proposed to be used for this freight terminal is a space 300 ft. in width, extending southward from Van Buren St. to Ewing St., 1920 ft. Beyond Ewing St. southward, the space to be occupied consists of a strip about 100 ft. in width, to serve as a right-of-way for the necessary approach tracks.

The main freight building to be a steel and masonry structure two stories in height, 300 ft. in width, and 800 ft. in length, extending from Van Buren St. to Harrison St., with tracks upon two levels. The lower level below the surface of the adjoining streets for outbound freight, and an upper level above the surface of the streets for inbound freight.

Between the two track levels teams would enter the building through doorways on Jefferson St. and Desplaines St., the interior driveways runnng transversely of the building upon the same level as the adjoining streets. All of the intermediate cross streets extend through the building, and thus maintain the continuity of the thoroughfares for street traffic.

Within the building freight would be received and delivered at platforms, the inbound freight being lowered from the cars to the teams, and the outbound freight lowered from the teams or trucks to the cars.

Under this arrangement the plan of handling freight is intensively developed to the extent that both inbound and outbound freight would be handled within the same area on different levels. This method of handling freight is an advance over any previous system used by the railways in Chicago, and will effect a considerable economy in the space used for this purpose.

The facility with which teams or trucks can approach the freight platforms and depart therefrom at the street level on all sides of the building, and the interior arrangements for handling the freight, are to be commended as progressive and advanced practice.

The general plan of this freight terminal is excellent. The location of the main freight building, fronting on Van Buren St. and extending south to Harrison St., is objectionable because of the obstruction it will offer to the proposed opening of Congress St. midway of the block between Van Buren St. and Harrison St.

It is apparent to any observer of the traffic conditions of the streets in the central business district of Chicago that relief from the congestion now prevailing can be brought about only by giving opportunity for the expansion of the business district westward as well as southward, and to this end the improvement proposed by the Chicago Plan Commission of opening Congress St. through to the West Side as a wide avenue of traffic is a consideration of importance to the ultimate development of a westward movement of business.

The Pennsylvania company, in locating its proposed new freight terminal west of Canal St., evidently had in view the redistribution of this traffic by the use of Canal and Clinton Sts. as the main thoroughfares.

With the increased freight traffic thus thrown on Canal St. there will be a much heavier use of the street than ever before, as it may become the main thoroughfare for heavy north and south traffic from not only the South Side, but as well from the North Side, and will also carry a substantial portion of West Side traffic to the railway freight terminals and warehouses that may in time line Canal St. on both sides from Harrison St. to 15th St.

To meet this situation and at the same time provide an adequate and suitable thoroughfare for the passenger traffic to and from the Union Station, Canal St. should be widened to 100 ft. from 12th St. to Harrison St., and if possible further north, by extending the street eastwardly 20 ft. over railroad property and supporting it over the tracks below.

It would be advisable to reconstruct the street upon two levels, the upper level for rapidly moving through traffic, and the lower level for slow-moving local traffic. The through cross streets to connect with the upper level and the short cross strets to connect with the lower level.

With these provisions for improved street traffic, the location of the Pennsylvania freight terminal west of Canal St. will be of advantage by relieving the congestion in the freight yards as well as the streets, and the capacity for greatly increased business which the new terminal will afford will be of advantage to the mercantile and industrial interests as well as to the railroad.

I would also recommend the consideration of the widening of Harrison St. in the near future, by increasing the width of the roadway to the present building line on each side of the street, and adding to the present street width sufficient space on each side for the necessary sidewalks.

This can be done in a comparatively economical manner by having the first stories of the more expensive buildings cut back the width of the new sidewalk, thus forming an arcade under the second story.

It will therefore be of general advantage and benefit to the business interests of the city and the railroad that the location of the new Pennsylvania freight terminal west of Canal St. be approved, provided the plan is amended to eliminate the objections which have been made to it.

The north line of the main freight building which it is proposed to locate on Van Buren St. can be set back from Van Buren St. to Harrison St., and no portion of the proposed terminal should be permitted to extend north of the south line of West Harrison St. widened, excepting such utilization of the property between Van Buren St. and Harrison St. as can be made below the level of the street grades, and without interfering with the future extension of Congress St. This can be done by the railroad company without impairing the integrity or capacity of its terminal improvements.

For the proposed elevated structure to carry the freight approach tracks from 21st St. and Stewart Ave. northward to Taylor St., between Jefferson and Desplaines Sts., depressed tracks should be substituted west of the Chicago River at a level that will pass under all of the intervening streets.

The question of some improved method of handling the enormous tonnage of freight which is shipped in and shipped out of Chicago is a very important one, when it is considered that this tonnage is largely in excess of the freight shipped into Chicago for consumption in the city. The "shipped-in shipped-out" freight is now largely handled through the streets of the business district in its movement from the railways to warehouses on its inward journey, and is again hauled through the streets from warehouses to the railway stations on its outward journey; much of it in the original form in which it was received. A great deal of the congestion of the streets in the business district of the city is due to the handling of freight which is foreign to the city, and which could with advantage to the community be handled outside of the business district.

The establishment outside of the city limits of a clearing house for the handling of less-than-carload freight, in connection with universal freight houses located conveniently within the city, is an advanced method of handling freight, which is worthy of the most careful investigation, as it has possibilities of great relief to the traffic upon the city streets.

With a definite trend southward of the business district of the city, and the consequent advancing real estate values, it would appear reasonable that the enhanced value of the land released from railroad use north of 12th St. on the South Side that would result from the opportunity to make use of such land for the construction of commercial and office buildings, would yield returns more than sufficient to cover the expense to the railroads of moving the freight facilities now there to new locations and adopting improved methods of freight operation.

Progress of the Canadian Steel Industry—It would almost appear that, if the present rate of progress in steel manufacture continues, Canada will be able soon, not only to supply her own wants as regards steel, but also be able to enter the markets of the world. Prior to 1903, Canada made very little steel. The output advanced from 26,084 gross tons in 1901 to 182,037 gross tons in 1902. Five years later, in 1907, it had reached 646,754 tons, and five years later still, in 1912, it increased to 853,031 tons, the largest output in its history. It is quite probable that in the present year Canada will make nearly 1,000,000 tons of steel, or more than the United States made in 1879. The steel output of Canada is largely in the form of ingots, over 96% of the total in 1912 being in this form, and less than 4% in the form of direct castings. The two largest centers for steel in the Dominion are Ontario and Nova Scotia. In 1909 Nova Scotia led Ontario by 28,201 tons, in 1910 by 11,943 tons, and in 1911 by 20,623 tons. In 1912, however, Ontario forged ahead by 1321 tons. Nova Scotia has within its borders the new and modern plant of the Dominion Steel Corporation, while Ontario has within its boundaries the large and modern plant of the Algoma Steel Corporation. Naturally, the output of finished rolled forms of iron and steel in Canada increased in the same ratio as steel ingots and castings. In 1902 the total rolled output was 161,485 tons. In 1907 it had increased to 600,179 tons, and in 1912 to 861,224 tons, the maximum. Much the larger part of the total was steel—about 87.5% in 1912. Rails formed almost one-half of the total rolled output of the Dominion in 1912—over 49.2%. It was not till 1902 that Canada began to manufacture steel rails on a large scale. In that year it made 33,950 tons. Its output in previous years had seldom exceeded 800 or 900 tons. In 1912 the rail output reached 423,335 tons, its best yearly record.—["Engineering," London.]

Aesthetic Design for Drawbridges

Opportunities for the æsthetic treatment of bridges are somewhat rare, since as a rule, bridges are regarded mainly from the utilitarian point of view. Two boulevard drawbridges to be built over the Chicago River for the City of Chicago have offered a rather exceptional opportunity for treatment of this kind. One of these is to be on an extension of Michigan Ave., connecting the boulevard systems of the north and south sides of the city, and the other will carry a part of 12th St. which is to be converted into a boulevard. The former will be a double-deck structure, the upper deck being for automobiles and through traffic and the lower deck for teams and general business traffic along the water front. Designs for both of these structures were submitted by the Strauss Bascule Bridge Co., using a modification of the balanced-lever type of direct-lift bridge, described in ENGINEERING NEWS, of June 5, 1913.

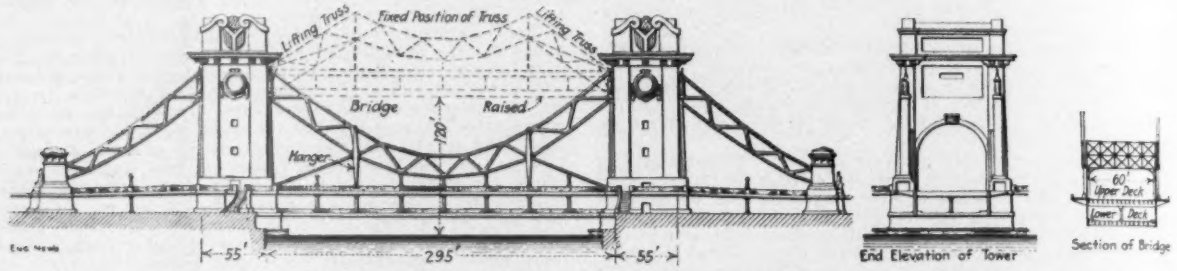
An unusual feature of these designs was the design of the structure itself with regard to æsthetic appearance, and also the introduction of masonry towers of architectural treatment, to mask the steel towers and operating mechanism, and also to utilize the steel towers in forming striking architectural features in the boulevard system. No design has yet been selected for the 12th St. bridge, and while a double-leaf double-deck bascule design* had already been adopted for the Michigan Ave. bridge before the submission of the lift-bridge design, it is understood that this project may be reconsidered. Although the two designs described are as yet no more than preliminary studies, they are worth noting as interesting examples of the possibilities of æsthetic treatment.

The pleasing effect of the design is indicated in the accompanying cut, which represents the bridge proposed for Michigan Ave. and shows the treatment of both the structure itself and of the tall masonry towers. The span is 295 ft., with a clear channel width of 240 ft. (on the square), and the height of lift is 120 ft. The design for the 12th St. bridge was essentially the same, except that it provided for a single-deck span.

The operating mechanism comprises two horizontal frames which are pivoted on the steel towers, as described in the article already mentioned. These frames carry counterweights at the rear end and are pivotally connected with the span at the forward end through a hanger, a link being connected with the hanger and counterweight so as to move the latter back and forth [illegible] its own pivot to a degree sufficient to maintain a [illegible] counterbalancing effect in all positions of the span. The operation is effected by means of racks on the [illegible] spans and pinions on the lift spans.

In order to obtain a long span with economy [illegible] in order also to carry out the idea of a monumental [illegible] ture in the two bridges noted above, the counter[illegible]ght frames were treated as part of a suspension tru[illegible]e- tween the towers, the central portion of this truss [illegible]ng a fixed part of the lift span. As this fixed part [illegible]es vertically while the counterweight frames rotate [illegible]t their centers the connection between the two must [illegible] a compensating one. This is effected by means of pivoted links in the top chord, which close up as the span rises and straighten out as it lowers.

In the open position of the span there is no stress on these links. In the closed position of the span they transmit the live-load which comes into the suspension trusses through the hangers and travels back to the towers and thence to the anchor trusses on the shore side of the towers, precisely as in a true suspension bridge. The dead-loads are carried through the same hangers into the counterweight frames and balanced by the counterweight, as already explained. The general appearance is that of a suspension bridge carried by catenary trusses.



DESIGN FOR DIRECT-LIFT, DOUBLE-DECK DRAWBRIDGE OVER THE CHICAGO RIVER AT MICHIGAN AVE., SHOWING PROPOSED ARCHITECTURAL TREATMENT OF THE TOWERS

(Strauss Bascule Bridge Co., Chicago, Designer.)

The monumental effect is completed by incasing the steel towers in masonry with architectural treatment as shown. Each tower thus becomes practically a portal over the roadway through which the boulevard traffic passes. These towers would form commanding features of the structure and distinguish the boulevard bridges from the ordinary street bridges. As the Michigan Ave. bridge would be near the entrance to the Chicago River, it would have the effect of a river gateway to the city, when seen from the Lake, while from the boulevard its portal would present the appearance of a monumental arch.

The masonry of the towers could be carried out in either concrete or stone. If the latter, the cost would be considerable, but it is believed that a satisfactory treatment in concrete can be secured which would be permanent and comparatively inexpensive. However, for a structure of this kind it would be proper to provide the necessary money for a suitable æsthetic treatment. The towers would not only house the bridge operators, but could provide storerooms and public-comfort stations, and would be suitable for various public purposes. Both the towers and the trusses would lend themselves to illumination for display purposes.

*"Engineering News," July 17, 1913.

A Gravity Concrete-Depositing Plant, Fallsway Viaduct, Baltimore, Md.

In the construction of the Fallsway Viaduct, in Baltimore, Md., the design of which was described in ENGINEERING NEWS, July 3, 1913, p. 2, the main part of the concreting is being done by one plant located near the middle of the work. Its layout is shown in Fig. 1. As will be noted there, it comprises a mixing plant with adjacent material houses, blacksmith shop, carpenter shop, etc., and a very high tower from which concrete is chuted to the various parts of the work through trough sections supported by cableways.

The plant is located on the north side of Eager St. about 25 ft. below the surface of the street. It is level with the top of the roof of the east conduit of Jones' Falls, which forms a base of the Fallsway Viaduct; this level is about 35 ft. below the adjacent tracks of the Western Maryland R.R. The south side of the plant is against the masonry of the Eager St. bridge and the material bins located there are about 2 ft. above the surface of the street. Two runways extend over the tops of these bins and the covering over the pavement of the bridge at this point makes an incline so that automobile trucks bringing in material can dump directly into the bins.

There are three bins: one of 50-cu.yd. capacity for gravel, one of 25 cu.yd. for crushed stone and one of 30 cu.yd. for sand. Each of these bins has a sliding door on the bottom which allows material to drop into a measuring box from whence it discharges directly into the mixer. These bins are located immediately alongside the railroad track so that a bucket elevator of 250 tons capacity per hour is installed to load into the bins whatever material need be brought in by rail. Some of the sand and stone is brought by trucks to the bridge and dumped while some is brought by train and lifted into the material bins.

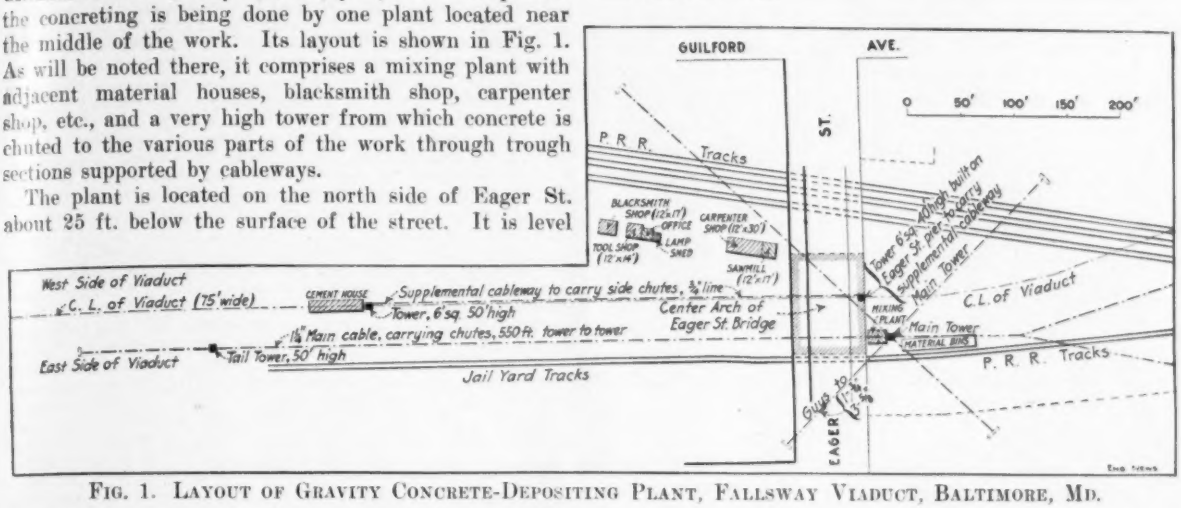


FIG. 1. LAYOUT OF GRAVITY CONCRETE-DEPOSITING PLANT, FALLSWAY VIADUCT, BALTIMORE, MD.

The cement house is located some 400 ft. north of the mixing plant. Cement is wheeled by hand from the cement house to the measuring box. Water is taken from an automatic tank which allows only a fixed amount to run in each time a batch is mixed.

From the mixer the concrete is discharged into a bucket which is then hoisted up the 200-ft. timber tower (shown in Fig. 3) and automatically dumped into a hopper when it reaches the top. This tower is of simple design, being made up of 6x6-in. vertical sticks thoroughly braced both diagonally and horizontally. It is guyed by three sets of lines; one at the top, one about a third way up and one about two-thirds of the way up, each extending in four directions as shown on Fig. 1.

When the bucket reaches the top of the tower and is automatically dumped by the device shown in Fig. 3, the concrete is let out into a hopper controlled by a hand-manipulated gate from which the concrete is led into the gravity chute, which is carried out over the work on a cableway from the main tower to a tail tower 50 ft. high and located about 500 ft. north of the main tower. The ¾-in. main suspending cable runs over the towers at either end to dead men, that at the lower tower being on line and those at the main tower being separated in order to provide clearance for the railway tracks.

The chutes, which may be noted in the view in Fig. 2, are made up of 10-in. plates bent into a three-quarter round trough and are supported over any desired length of span by hangers suspended from the main cableway. They are suspended from the cable by blocks and falls which reach to the ground for purposes of control. The chutes are made up of lengths varying from 10 to 30 ft. with two blocks and falls to each section. The extreme length of line of chutes is about 420 ft.

Opentop hoppers are provided at intervals (see Fig. 2), so that the line of deposit chutes can be placed at angles to be able to transmit the concrete from the main line to different points on the west side of the work, the main line of chutes being on the east side of the viaduct.

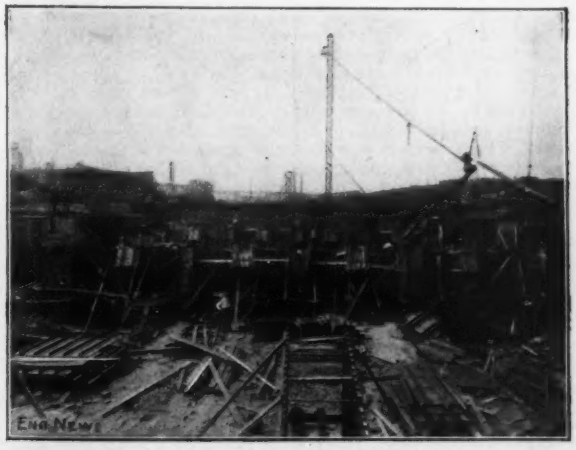


FIG. 2. LOOKING NORTH TOWARD DEPOSITING TOWERS, CONCRETE PLANT, FALLSWAY VIADUCT, BALTIMORE

The viaduct is about 75 ft. wide, which requires the chutes to be placed at angles to be supported at the middle. For purposes of support a supplementary cableway has been built west of the main supporting cableway. This cableway has a small traveler on it which holds the chutes at any angle, the one in the foreground of Fig. 2 illustrating the method.

This plant was built with the idea of covering the work for about 500 ft. on either side of the plant. For the retaining-wall work between the south abutment and Madison St. there has been built a small traveling mixing plant 14 ft. wide by 20 ft. long, on which is mounted a mixer and hoisting engine. A small tower about 30 ft. high is built on the floor of the car and the concrete is dumped into a bucket and hoisted up in the same manner as in the larger tower. From the hopper on top of the tower the concrete is run through a chute into the forms. This car, which runs on a standard-gage railway track, is never more than 25 ft. from the point at which it is desired to make the concrete, so that one section of chute is sufficient. Material is supplied by barrows, which are wheeled up an incline at the rear end of the plant.

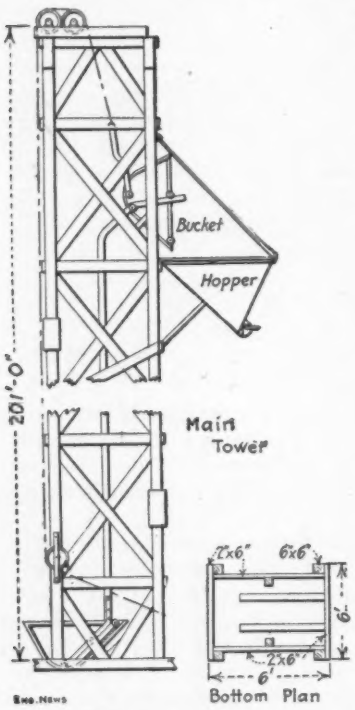


FIG. 3. DETAILS OF DEPOSITING TOWER

There is also on the work a locomotive crane used to lift the centers for the arches in position and move them from place to place; this crane is located on the west side of the work. In connection with the whole concrete plant there is a carpenter shop containing a band saw, rip saw, joiner, etc., all operated by electricity. The mixing plant itself has two sets of boilers and engines, one being installed for emergency purposes only.

The Fallsway Viaduct is being built by the City of Baltimore under the design and direction of Calvin W. Hendrick, Consulting Engineer. The contract is held by the Stewart-Jones Co. and Claiborne, Johnston & Co., at a price of $190,693.15. The plant described above is owned and operated jointly by the two companies.

A 75-Mile Aërial Cableway—It is anticipated that during the spring of next year, 1914, work will be begun on what will be one of the most novel undertakings of the world, a great aërial cableway about 75 miles long across the Himalaya Mountain barriers which separate the beautiful and famous "Vale of Kashmir," in the Native State of Kashmir, from the plains of the Punjab in northern India. This will be by far the longest cableway in the world, the longest at present being one of 22 miles in length in Argentina. It is expected that this cableway will solve for the Kashmir State the very serious present problem of transportation into the rest of the Empire of India. The excessive expense and long time required for transport communication across the mountains have always been great obstacles to the development of the resources and the growth in prosperity of the people of this state.

Owing to the loose conglomerate nature of the soil in this part of the Himalayas, which causes disastrous slips and falling of huge bowlders whenever there is any unusual rainfall, engineers who have studied the situation deem that it is impracticable to build a railway into Kashmir, and that not even a light electric railway would prove feasible. After the invention of Brennan's monorail system of transport the Government of Kashmir entertained strong hopes that this system would be well adapted to meeting the special difficulties of communication across the mountains, and Mr. Brennan, in his experiments with the monorail, was liberally assisted by subsidies from the Kashmir Government. However, it was found that the monorail system would also be impracticable, chiefly because of the sharp angles in the alignment which would be required, and also the danger from earth slips.

At the suggestion of Lieut.-Col. A. J. de Lotbiniere, a Canadian military engineer, whose services had been lent to the Kashmir Government as state engineer, it was decided to investigate the feasibility of an aërial cableway, and, if possible, to encourage private enterprise to enter on this project. The London firm of Forbes, Forbes, Campbell & Co. (9 King William St., London), bankers and engineering agents, were induced to undertake a survey to ascertain the possibility of erecting a cableway. This survey has been completed and has demonstrated to the satisfaction of this firm and of the Kashmir Government that the scheme is practicable and will not be unduly expensive. Accordingly an arrangement has been made whereby this firm will organize a company to undertake the work under a concession from the Kashmir Government, which will subscribe for one-third of the capital stock. It is anticipated that the cost will amount to about $1,500,000. It is proposed to operate the cableway by electricity generated by water power at a station near the town of Rampore

The cableway will be constructed in spans of about 2400 ft. each with fixed cables upheld by steel towers, some of which will have to be 100 ft. high. The line will be divided into 5-mile sections. There will be cables for both outgoing and incoming freight, which will be about 9 ft. apart. The diameter of the cables will be about 1½ in. From these cables steel cars, holding 335 to 450 lb. each, will be suspended and conveyed, about 30 to every mile. These cars will be carried over great gorges and precipitous hills, and in some instances there will be a sheer drop beneath them of 1200 ft. The transfer of cars from section to section will be automatically accomplished. On account of the difficulty of expansion and contraction from heat and cold, the cables will be equipped with a complicated system of springs. The cableway will follow the gorge of the Jhelum River, which it will frequently cross and recross, accordingly as the spans can be most conveniently constructed, and the towers be located where there can be safety against slipping and dangers from falling bowlders. It will extend from the city of Baramula, at the entrance to the floor of the Valley of Kashmir, to Abbottabad, 75 miles away, situated in the Orash Valley, which town is shortly to be connected with the Northwestern Ry. System operating in the Punjab, at Hasan Abdal, about 44 miles away. From Baramula the cableway will be connected with Srinagar, the capital of Kashmir, by an electric railway a distance of about 38 miles. Baramula, the Kashmir terminus of the cableway, is 5150 ft. above sea-level, and Abbottabad, the terminus at the other side, is 4200 ft. above sea-level. (U. S. Consular Reports.)

A Program for Handling Wrecks has been prepared for each division of the Pennsylvania R.R. A designated officer of each department goes to the scene of the accident, where a joint investigation is made to determine the cause. A report of the results passes through the hands of the following: The superintendent who takes such action to prevent repetition, as may be deemed necessary; the general superintendent who checks the work of the superintendent, and finally the general manager, who through his accident bureau draws such conclusions as may be warranted by the facts in the report, and recommendations are issued. The motive-power department is provided with full information as to the number and cost of all accidents resulting from motive-power defects, and the operating and the maintenance-of-way departments also are provided with information pertaining to accidents which result through failures in those departments.

War-Time Railroading in Mexico

Maj. Charles DeLano Hine, who recently resigned as Vice-President and General Manager of the Southern Pacific R.R. of Mexico, entertained the members and guests of the St. Louis Railway Club on Oct. 10 with some interesting reminiscences of his experience in trying to operate a railroad in our neighboring republic on the south. An abstract of Maj. Hine's paper* is given below:

In the 20 months since February, 1912, when the second of recent Mexican revolutions was started, the Southern Pacific of Mexico has been in full operation only six months. During the other 14 months from 10 to 80% of its mileage has been out of commission at various times and in various places.

At first the officials, who are all Americans, and the employees, who are nearly 90% Mexicans, strained every nerve to crib bridges and to resume traffic. As time has worn on, however, all reserve energy has naturally been dissipated, the abnormal has become the normal, and the exceptional has lapsed into the routine. A train dispatcher is not startled if his wire suddenly goes down before the orders are completed. He knows from experience that the wire may not come up until perhaps tomorrow, next week, or mayhap next month or next year.

Occasionally the attacking band will take possession of the locomotive and burn some or all of the cars in the train. Usually, however, in the course of a week or two the wire comes up and a conductor asks for running orders from an office many miles from where he was last located.

Such primitive conditions have developed splendid initiative and resourcefulness on the part of officials and employees of all grades. From the president (Epes Randolph, a famous engineer and railway builder), who happened to be on the first train held up by armed force, down to the humblest laborer, all have followed Rule L of the standard code, reading: "In case of danger to the company's property, employees must unite to protect it."

Ofttimes this has meant dauntless and unflinching exposure to rifle or cannon fire. Habitually, it has entailed inconvenience and physical hardship. Officials who normally use comfortable business cars have taken to small motor cars, to track velocipedes, to push cars, or have traveled many miles on foot.

On one occasion the writer's motor car was run by a man who had been a railroader, a frontier deputy marshal and a chauffeur. For the particular trip in question he united the desirable qualities of a careful motorman, a crack shot and a good cook. The first night was spent in a tool house, one night in a freight house, another in a waiting room and still another in the open country. The car was towed around burned bridges through the arroyos (channels of dry streams).

On another trip a good-sized river had to be crossed, the long trestle approach to the steel bridge having been burned some weeks before. Visions of swimming the river like Funston in the Philippines were ended when the thoughtfulness of an assistant superintendent showed a section gang as water rats towing a raft made of ties.

This interchangeability of function is typical of the all-round training inculated on the Southern Pacific of Mexico by the unit system of organization. Two years of complete and consistent application of the underlying principles of this rational and practical system have produced gratifying results. Today every department, including traffic and accounting, has available from one to three developed and tested understudies for every official position. Coincidentally during the only period of eight months when conditions approached normal, the operating ratio with normal maintenance charges fell from 97 to 78%.

In May, 1912, after operation of the Sinaloa division had been suspended for over three weeks, it was deemed advisable to move all obtainable equipment north to Empalme, Sonora, near Guaymas, where conditions were tranquil. There were only a dozen locomotives at division headquarters in Mazatlan, Sinaloa, 275 miles south of San Blas, Sinaloa, the north end of the division, and a total of some 500 cars within reach. It was feared that insurrectos might cripple the movement by burning bridges between trains Not only did bridges have to be hurriedly cribbed, but water tanks had to be repaired, some having been riddled with bullets.

On Monday morning the procession started with a train order reading somewhat as follows: "All engines on division run extra to San Blas with right over all southbound trains until 10:00 p.m., Friday, May 10, and protecting carefully against following trains." Some 60 hours later the senior vice-president, renewing his yardmaster days, tied up the last train on the main track, at San Blas, and then issued an order congratulating the Sinaloa division, through its superintendent, on a performance easy anywhere else, but most difficult under the circumstances.

Regular traffic was not resumed for several weeks. Meantime a "cruiser train" was put on. Passengers rode in the caboose. No cars were left at stations, but freight offered was loaded in empties in the train. After cruising all day, the train tied up wherever night overtook it. The danger of encountering a hole instead of a bridge precludes much night running in times like these.

On Mar. 5, 1913, the state of Sonora revolted against the newly established Huerta government, and seized that portion of the Southern Pacific of Mexico lying north of Empalme. For six weeks the officials of the road were powerless. Operation was carried on from Hermosillo, the capital of the state of Sonora, by the state officials, with six locomotives and other equipment forcibly seized. Methods of alleged confiscation of railway property in the United States are perhaps crude after all. Six weeks of such operation gave the state officials their fill. Outgo so exceeded income that the road was unconditionally returned to its owners.

*Reprinted in full in the "Railway Age Gazette" of Oct. 17.

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Basalt Facing for Concrete Wall, Hamburg Harbor

A striking peculiarity of the harbor work in Hamburg is that all the concrete walls are faced with basalt laid up in the roughly hexagonal pattern of the natural columnar formation of basalt. It is considered that a natural concrete surface undergoes sufficient deterioration to entail large maintenance expense (after a time, at least) if the appearance of the surface is to be kept passible. Masonry facing is believed to be the best preventive of deterioration. Judging from the amount of masonry-faced concrete to be seen, this view is held not only in Hamburg, but quite generally in Europe. Basalt is used at Hamburg because it combines remarkable permanence with a relatively low cost, in spite of having to be brought in from a considerable distance. Some information on the cost and other conditions is given in the following statements in a letter from Baurat Wendemuth, of the Hamburg Water Board:

The basalt is obtained from quarries on the middle Rhine, and is brought to Hamburg by water, so that the transportation cost is not higher than in the case of other natural stone for facing. Further, the mason labor does not go higher than for bedded stone, because the small blocks of basalt are very handy. The masons employed in the work are specially skilled in laying up the basalt masonry, and execute it rapidly and skillfully.

The cost of the basalt facing, including material and labor, has lately varied between M18 and M23 per sq.m. ($0.40 to $0.53 per sq.ft.). The present price paid for mason labor is about 26c. per hr. for masons, and 25c. per hr. for helpers.

⁂

Recent Central American Earthquakes have caused a remarkable depression in the bed of the ocean off the coast of Panama, according to press dispatches. It is stated that at a point about 15 miles from the mainland, near Los Santos province, where a depth of 1000 ft. was shown on the chart of the United States War Department published in 1904, a depth of 5000 ft. now exists. The cable ship sent to the locality to repair the cable broken by the earthquake found one end of the cable hard and fast beneath a mass of material recently superimposed over it. The zone of displacement is about half a mile wide, according to the ship's soundings. It is suggested that this is probably the "hole in the bottom of the sea," celebrated in the familiar song!

The Memphis Cantilever Bridge

A great cantilever bridge which is being built across the Mississippi River at Memphis, Tenn., will be the second bridge at that point and will form an important addition to the long list of notable cantilever bridges, which are a feature of American bridge engineering. The bridge is being built by the Arkansas & Memphis Railway Bridge & Terminal Co. for the joint ownership and use of the Rock Island Lines, the St. Louis, Iron Mountain & Southern Ry., and the St. Louis Southwestern Ry. The capital stock of the company is held in equal parts by the railway companies. The lines of these three systems terminate on the west side of the river, and the construction of the new bridge will greatly reduce the present transfer charges at this point. In connection with the bridge there will be extensive terminals. The bridge was authorized by act of Congress, July 20, 1912 (amended Aug. 23, 1912), and the plans were approved by the War Department (U. S. Corps of Engineers) on Aug. 15, 1913. Work has been commenced on the substructure.

The bridge has been designed by Ralph Modjeski, of Chicago, who is consulting engineer for the bridge company (and who was assistant engineer on the present bridge, opened in 1892). It will be built under his supervision. The contract for the substructure has been let to the Union Bridge & Construction Co., of Kansas City, Mo., on a percentage basis. The contract for the superstructure will not be let until toward the end of this year or early next year.

The new bridge is parallel with and 200 ft. upstream from the present structure, and its main channel spans, therefore, have the same openings as those of the older. The west pier (No. 4), however, is 17 ft. farther out in the river, in order to shorten the suspended spans, which have a length of 417 ft. 9¾ in., as compared with 451

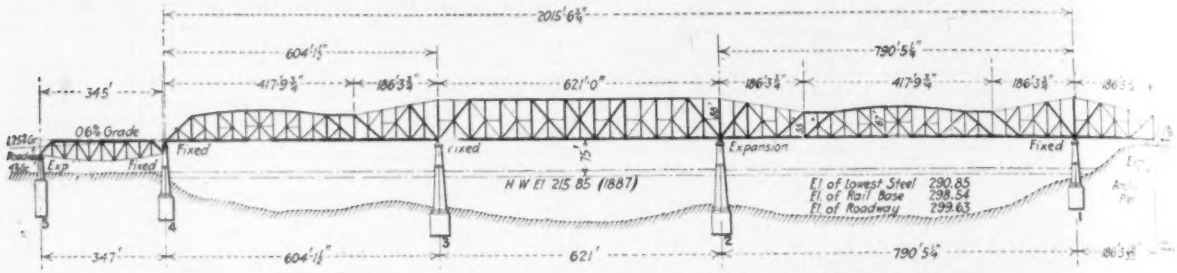

FIG. 1. THE NEW CANTILEVER BRIDGE OVER THE MISSISSIPPI RIVER AT MEMPHIS, TENN.; ARKANSAS & MEMPHIS RAILWAY BRIDGE & TERMINAL CO., RALPH MODJESKI, CONSULTING ENGINEER

ft. 8 in. in the present bridge. The arrangement of the spans is shown clearly in Fig. 1, and includes the following: (1) An anchor arm of 186 ft. 3¾ in., forming the east span; (2) a cantilever span of 790 ft. 5¼ in. (cantilever arms 186 ft. 3¾ in. and suspended span 417 ft. 9¾ in.); (3) a fixed span of 621 ft.; (4) a cantilever span of 604 ft. 1½ in., having a cantilever arm of 186 ft. 3¾ in. and a suspended span of 417 ft. 9¾ in., the shore end of this being carried by a pier; (5) a deck-truss span of 345 ft.

At the east end, the high ground extends to the anchor arm of the main bridge, but at the west end there will be a steel viaduct approach about 2360 ft. long. The bridge will carry two tracks between the trusses, and two outside roadways 14 ft. wide on cantilever floor beams. At the east end the railway approach has a grade of 1.1%, running into the level by a vertical curve, which extends one panel length on each side of the pier (No. 1). At the west end, the approach grade is 0.6%, with a similar vertical curve connection. The clear headway is 75 ft. above the high-water level of 1887 (el. 215.85).

The cross-section and the anchorage at the east end are shown in Fig. 2.

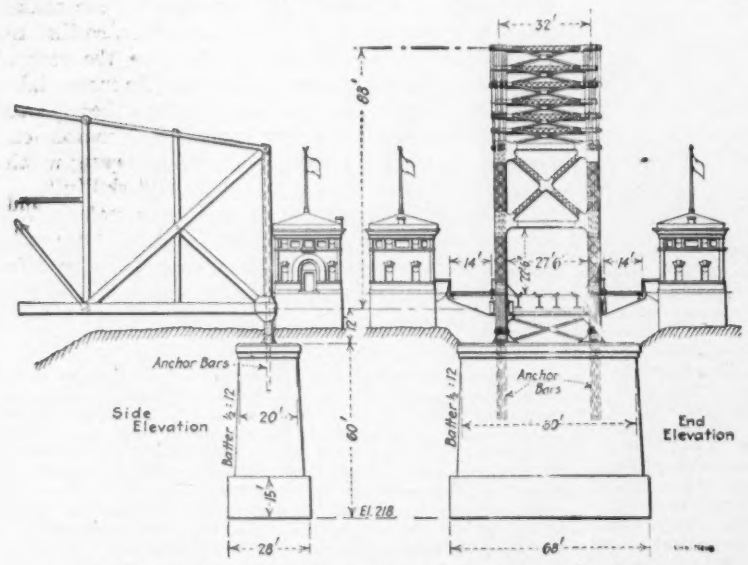

FIG. 2. END ELEVATION AND ANCHORAGE OF THE MEMPHIS CANTILEVER BRIDGE

SUBSTRUCTURE—The five piers will be founded on pneumatic caissons sunk to depths of probably 110 ft. at the two channel piers and 70 ft. at the three shore piers. The piers will be of the form shown in Fig. 3, and will be of concrete, faced with granite from Stone Mountain, Georgia. They are 14x54 ft. under the coping. The anchor pier at the east end (Fig. 2) will be of reinforced concrete. The caissons will be of timber, and those for the channel piers will be 42x90 ft. over the cutting edge, with a height of 50 ft. 9 in.; above this, crib work will be carried up as required. The caisson construction is shown in Fig. 4. The first caisson was launched

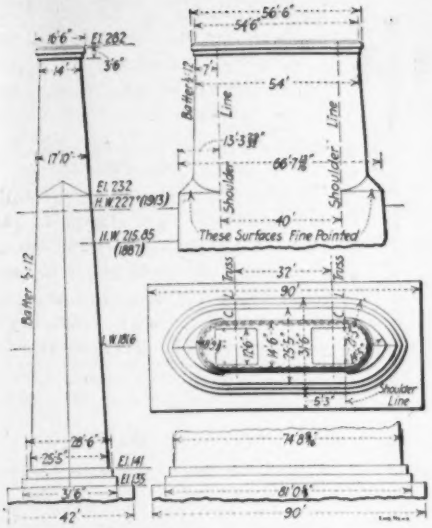

FIG. 3. MAIN PIERS FOR THE MEMPHIS BRIDGE

in October. The material encountered in the river bed is mainly gravel, sand and hard clay.

SUPERSTRUCTURE—The superstructure comprises the three main spans, an anchor-arm shore span at the east end and a deck-truss shore span at the west end. The trusses will be spaced 32 ft. c. to c., and will have a depth of 88 ft. over piers Nos. 1, 2 and 3, and 55 ft. at the ends of the cantilever arms. Two designs are being prepared, as follows: 1, with all truss members (except those in the anchor arm) of alloy steel having an elastic limit of 48,000 to 50,000 lb.; 2, with alloy steel for the eye-bars and carbon steel for the remainder of the structure.

The details of the structure have not yet been completed, but Fig. 5 shows the character of details of the large members on the pier. This represents the design for the use of carbon-steel structural members and alloy-steel eye-bars.

LOADS—The loading assumed in the calculations is as follows:

A. Trusses. Live load 4000 lb. per ft., and 40,000 lb. concentration on each track; also 500 lb. per lin.ft. on each roadway (except in the case of the suspended span, where 600 lb. per lin.ft. was calculated). The unit stresses have been taken conservatively, so that even with a loading on each track corresponding to Cooper's E-70, no member in the bridge will be stressed over 66% of the elastic limit.

B. Track Floor. Two 177½-ton locomotives on each track (Cooper's E-50 loading).

C. Roadway Floor. A 17½-ton road roller and 100 lb. per sq.ft.

D. Wind Loads. For loaded structure; 30 lb. per sq.ft. on train and floor as seen in elevation, and in addition the area of truss members for two trusses. For unloaded structure, 50 lb. per sq.ft. of exposed area of members for two trusses.

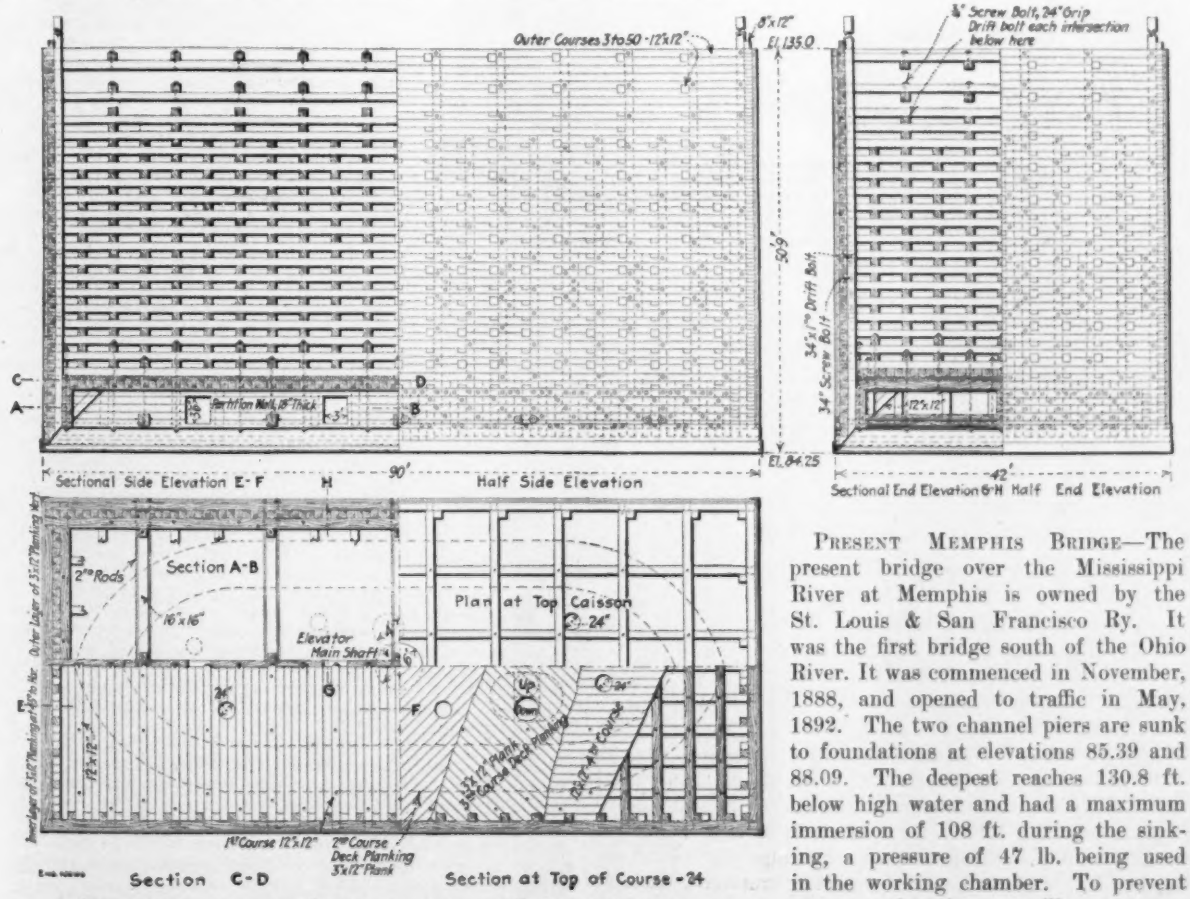

FIG. 4. FOUNDATION CAISSONS FOR THE MEMPHIS BRIDGE

PRESENT MEMPHIS BRIDGE—The present bridge over the Mississippi River at Memphis is owned by the St. Louis & San Francisco Ry. It was the first bridge south of the Ohio River. It was commenced in November, 1888, and opened to traffic in May, 1892. The two channel piers are sunk to foundations at elevations 85.39 and 88.09. The deepest reaches 130.8 ft. below high water and had a maximum immersion of 108 ft. during the sinking, a pressure of 47 lb. being used in the working chamber. To prevent scour at the piers, a willow mattress

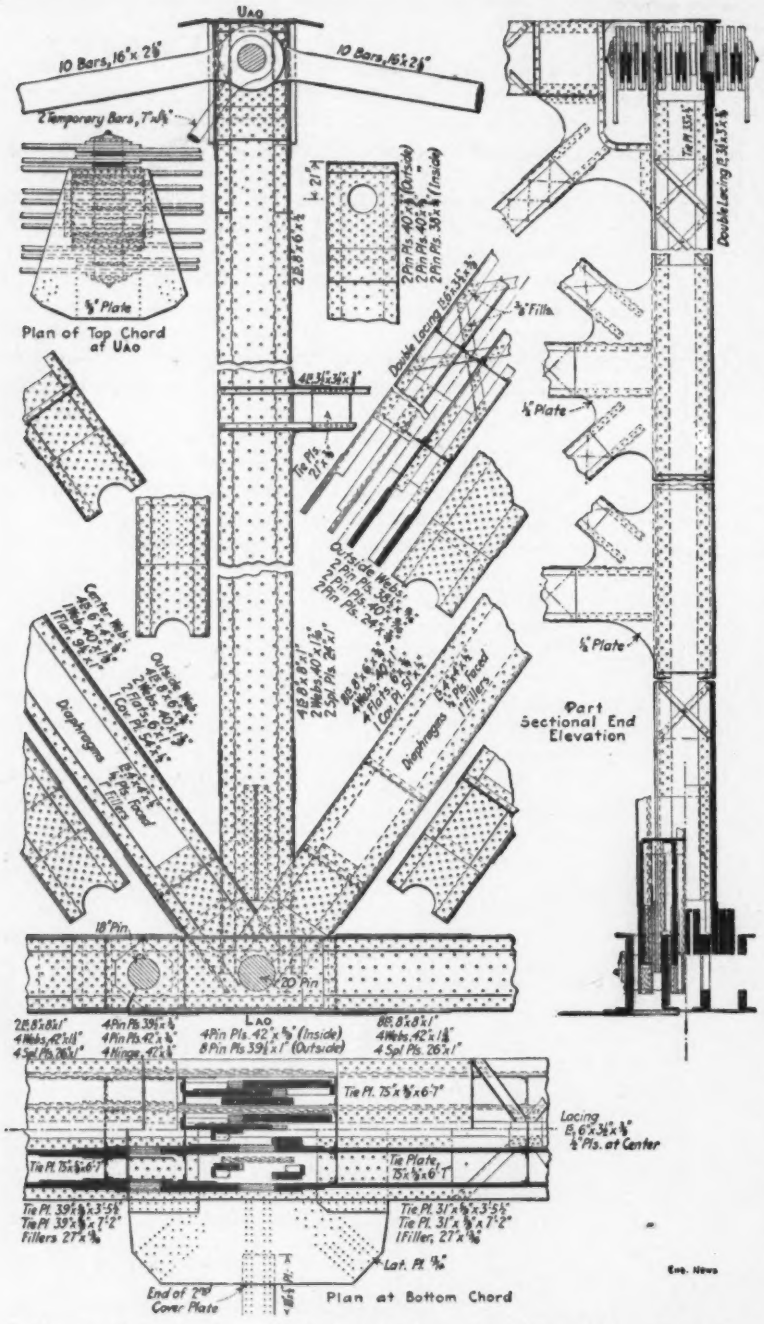

FIG. 5. TRUSS OF SECOND MEMPHIS CANTILEVER BRIDGE, AT PIER 1

was sunk at the site of each pier by loading it with stone, and the caisson cut through this in its descent.

The arrangement of the superstructure is as follows, beginning at the east end: (1) An anchor arm of 225 ft. 10 in.; (2) a cantilever span of 790 ft. 5¼ in. (cantilever arms 169 ft. 4½ in. and suspended span 451 ft. 8 in.); (3) a fixed span of 621 ft.; (4) a cantilever span of 621 ft., having a cantilever arm of 169 ft. 4½-in. and a semi-suspended span of 451 ft. 8 in.; (5) a deck-truss span of 338 ft. 9 in. It is a single-track bridge, but the trusses are 30 ft. c. to c. to give the necessary transverse stability on the long spans. The entire width of the bridge deck between fences is planked to form a roadway for the use of teams, but teams and railway trains are not admitted on the bridge at the same time. The weight of the superstructure (not including the approach viaduct) is about 8000 tons.

The bridge was designed by the late Geo. S. Morison, and was built under his direction. Mr. Modjeski (the engineer of the new bridge) was assistant engineer, and he designed the expansion-joint used in the main spans, described in our issue of Dec. 1, 1892. This bridge was fully described and illustrated in ENGINEERING NEWS, May 12 and June 16, 1892, Sept. 7 and Dec. 28, 1893.

Railway Development in China—China's railway history began in 1876, when the Woosung line, built by foreign enterprise, was opened. In 1877 the road was redeemed by the Chinese, and the rails torn up and the equipment shipped to Formosa. In 1887, however, a railway was in operation between Tientsin and Tongshan.

With the marked awakening of China there has come the acute realization that the development of the country depends upon means of rapid communication, and out of the maze of projects advanced throughout the length and breadth of the Republic there is now gradually being evolved a series of trunk lines and connections to form the principal arteries of trade.

The present problem is primarily a financial one, but there stands out with equal prominence the delicate question of nationalization, the difficulties of foreign treaties, concessions, agreements and understandings, and, not least important, the overcoming of engineering difficulties.

At this date many plans that had begun to assume a promising aspect have received a serious setback by the outbreak of political disturbances in the Yangtze Valley and the South. That they will delay progress there is no doubt, but how far cannot be forecasted. Suffice it to say that the awakening in this vast Republic, though recently more spontaneous and enthusiastic, is none the less real. The coming decade must see great advances; and the financing, construction and equipment of China's new railways will offer an immense field for foreign enterprise and industry.

According to the latest available statistics, the Republic of China is now possessed of 5960½ miles of line opened to traffic and has under construction 2273 miles.

On this basis, China proper has less than 0.4 mile of open railway to every 100 square miles of territory, and, estimating the population at 327,000,000, there is 0.18 mile of line to every 10,000 inhabitants. [U. S. Consular and Trade Report, Oct. 20, 1913.]

The Observance of Safety Rules which relate to the protection of trains and employees, was checked by the Pennsylvania R.R. in nearly 185,000 instances, during August, and in only 79 cases failure was reported. In 1852 tests to determine the observance of signals for danger, only one failure was reported. Of 526 signals set at caution, there were three failures. Tests were made of the observance by engineers of flagman's signals in 1321 cases, and the result was perfect obedience. Attention also was given to the performance by flagmen of their duty; 5989 tests were made with but 13 failures. Conformity of engineers to speed regulations was tested in 6570 cases, with 21 failures. In 12,012 tests to ascertain whether trains were leaving and arriving at stations ahead of time, the results were perfect. Observance of regulations as to handling explosives and inflammables was tested in 9960 cases with but two delinquencies.

EDITORIALS

A Plea for Earth Roads

In the valuable paper on the brick roads of Cuyahoga County, Ohio, by James M. McCleary, County Engineer, published in our issue of Oct. 16, occurs the following:

> A satisfactory plan for an average county road may include a paved portion anywhere from 9 to 16 ft. wide with a dirt or gravel macadam road occupying the balance of the width. Immediately you ask, "why a dirt road"? The best answer is, "ask the farmer" and he will tell you to "ask the horse."

In all the voluminous good-road literature now being showered upon the public from many quarters, one will search a long time to find any mention of the fact that during six to ten months of the year a good earth road suits the needs of the farmers better than any type of paved roadway. While it is true that the farmers may prefer a good macadamized road to the average ill-maintained country highway, which is too often a succession of mud puddles and holes in the hollows and of humps and stones on the hills, it is, on the other hand, equally true that a well graded and well kept dirt road is a pleasanter and easier road to ride over than any paved roadway. A horse driven over such roads can travel more miles in a day with less fatigue than on paved roads. Every owner and user of horses knows that horses used habitually on pavements and hard roads wear out much more rapidly and are especially subject to diseases of the legs and feet; also the cost of keeping them shod is much greater.

These are matters extremely important to the farmer and those who expect to gridiron the country with paved roadways will do well to realize the situation.

A part of the public dissatisfaction with the New York State roads is due to the fact that the locators and builders of some of these roads failed to realize the extent of the public preference for earth roads during the summer season. We are informed that there are sections of the New York State roads built at high cost where the bulk of the traffic follows a beaten track alongside the paved road rather than travel over the latter.

Nor is horse traffic alone in preferring good earth roads under certain conditions. Where the automobile traffic to be taken care of is chiefly that of summer tourists, it is found that a well built and well maintained gravel road is preferred by automobilists to a macadam roads, or even to roads paved with more expensive materials. The gravel road is springy and resilient and gives a good grip to the tires. It does not produce the jar that exists in riding over a paved road with unyielding foundations.

We are, of course, not opposing the building of macadam or concrete or brick or asphalt-covered roads where the character and volume of the traffic justifies such construction. What we do urge is that the current agitation for "good roads," and the current fallacy that by spending enough money on construction a road can be built which will cost nothing to maintain, should not lead to the wasting of millions of dollars of public money on the construction of roads which will give less satisfaction to the users than a well built and well maintained earth road.

Evolution of the Gasoline Rock Drill

The persistent effort to develop a commercial gasoline rock drill shows the need for such a tool. While it is not at all likely that such a machine would seriously compete with the very efficient compressed-air drills now on the market, it should find a large field of usefulness where the amount of rock drilling to be done is not large enough to install a compressed-air plant or even a steam boiler. There is a great deal of work on foundations, trenches, road construction and repair, small quarry operations and in mining work on prospecting and development, where a compact and portable rock drill developing its own power would be a most welcome tool.

One of the early attempts in this direction was the "Bull Dog" rock drill, manufactured in Philadelphia (ENGINEERING NEWS, Apr. 13, 1905). Here the engine was not a part of the drill, the latter being a crank-and-hammer mechanism driven from a separate engine by a flexible shaft. This drill was satisfactory in its cutting speed, but the impact crystallized the crankshaft and its life was short.

A few years later, L. L. Scott, of Joplin, Mo., built a drill, of which the driving element was a pair of two-stroke-cycle gasoline engines (ENGINEERING NEWS, Nov. 26, 1908). This machine was both clumsy and complex, involving a spring-mounted wrist-pin engaged by a connecting-rod which drove a short crankshaft. An English gasoline drill briefly noted in ENGINEERING NEWS, for Nov. 17, 1910, also had a crankshaft between the engine cylinder and the pit.

Mr. Scott has recently brought out another gasoline drill (ENGINEERING NEWS, Apr. 17, 1913). Experiment convinced him that to make the blow most effective, the piston should be free from the crankshaft at the moment of impact. His new drill is of the hammer type; the bit receives a rapid succession of blows transmitted from the piston of a single-acting two-stroke-cycle gasoline engine. The bit itself has no reciprocating motion as it has in the piston-type drill.

Elsewhere in this issue we describe the latest gasoline rock drill, which has been developed by John V. Rice, Jr., the inventor of the "Bull Dog" drill noted above. This machine is similar in design to the compressed-air drill in that the operating piston and the drill bit move together as one piece. The apparatus comprises two cylinders opposed to each other. The explosion in the rear cylinder drives the drill bit, which is held by the bit chuck on the end of the piston rod, forward against the rock. The function of the forward cylinder is to return the piston for the next stroke.

An Engineers' Committee to Draft a Federal Water Law

The recent action of the American Society of Civil Engineers in creating a special committee to draft a national water law deserves hearty commendation. We have frequently urged that this Society, as the leading representative body of the civil-engineering profession, ought to assume the responsibility of leadership in movements looking toward the betterment of those public affairs in which the engineer is most directly interested and concerning which he has greatest knowledge.

The need of Federal action with respect to water rights in interstate streams has been many times urged in these columns. At the annual convention of the Society in Seattle, Wash., a year ago, a notable paper was read by Mr. John H. Lewis, State Engineer of Oregon, on state and national water laws, with a description of the Oregon system of water titles.

Following the reading and discussion of this paper, Mr. Lewis, at the meeting of the Society on May 7, 1913, submitted the following motion:

> That the Board of Direction of the American Society of Civil Engineers be and is hereby authorized and directed to appoint a Special Committee to investigate the advisability of drafting a National Water Law applicable to all navigable, interstate and other waters within the jurisdiction of the United States, and embracing all uses of water, and that such committee be directed to prepare a preliminary draft of such law for submission at some regular meeting of the Society, if, in their judgment, it appears advisable.

The meeting referred the motion to the Board of Direction and the motion was adopted by the Board at the meeting of June 4, since which time the following committee has been appointed to undertake the task called for: George G. Anderson, Denver, Colo.; Charles W. Comstock, Denver, Colo.; H. S. Ferguson, New York City; Clemens Herschel, New York City; Robert E. Horton, Albany, N. Y.; John H. Lewis, Salem, Ore.; Charles D. Marx, Stanford University, California; F. H. Newell, Washington, D. C.; Gardner S. Williams, Ann Arbor, Mich. President Swain has selected Mr. F. H. Newell, Director of the U. S. Reclamation Service, as Chairman of the Committee.

To those who hold that the engineer is merely a narrow technician and is incapable of dealing intelligently with complicated questions of law, finance and business, we recommend a study of Mr. Lewis' paper. The paper has now been published in the "Transactions," with the accompanying discussion, which was contributed by such well known engineers as Clarence P. Johnston, of Wyoming, L. J. Le Conte, of California, Morris Knowles and Kenneth C. Grant, of Pittsburgh, Morris Bien, chief law officer of the Reclamation Service, and H. T. Cory, formerly of the Harriman lines.

If a Congressional committee, dealing with proposed legislation with respect to water rights desired authoritative opinions for its guidance, we venture to say that it would find more intelligent and practical information and suggestions in this paper and the discussion upon it, and in similar papers which have been prepared by engineers, than in any similar discussion carried on by members of the legal profession.

Nor is there anything remarkable in this fact. The engineer by his education and experience, at least when he deals with the larger tasks of the profession, is accustomed to study and to reason on broad lines. Instead of constantly appealing to past precedents, he becomes accustomed to searching for means to accomplish a task better than it has been accomplished before. He sees more clearly the evil results of antiquated laws and precedents relating to the use of water than does the lawyer who has been accustomed all his life long to regard such laws and precedents as the final word upon the subject.

We earnestly hope, also, that the appointment of this committee is the beginning of a new and progressive policy on the part of this great Society. There is no larger opportunity for leadership open to any body of professional men than is open to the engineers of this country, if and where they can coöperate in undertaking such leadership and can show themselves equal to the task they undertake.

A Remarkable Offer by the United States Government to Owners of Patents and Copyrights

An astonishing example of the carelessness with which Congress manufactures laws is the Kahn Bill (H. R. 7595), which was passed by the House of Representatives on Sept. 9. This bill was framed ostensibly in the interest of the Panama-Pacific Exposition, and its first section, which is unobjectionable, provides that foreign goods imported for exhibition there and not sold in this country shall be free of all duty.

The second section provides in substance that any manufactured article which is imported for and shown at the exposition and which is protected by any certificate of registration, copyright, trade-mark or patent issued by a foreign country, shall be protected in the United States, the Register of Copyrights and the Commissioner of Patents being required to register all such foreign copyrights, patents, etc., without charge.

The third section provides that it shall be unlawful for any person without authority of the proprietor to copy, imitate, reproduce or republish any pattern, model, design, trade-mark, copyright or patent article protected by the laws of any foreign country and imported for exhibition purposes at the Panama-Pacific Exposition. Any person infringing upon the rights of any such proprietor of a foreign copyright or patent shall be liable to the proprietor for damages, and any person who willfully and for profit infringes any right protected by this act, or who aids in such infringement shall be guilty of a misdemeanor, and upon conviction therefor shall be punished by imprisonment for not more than a year or by a fine of $100 to $1000.

According to the terms of this act, therefore, any holder of a foreign patent, copyright or trademark can secure in the United States, by simply exhibiting his goods at the Panama-Pacific Exposition, far more complete protection than is afforded by the United States patent and copyright laws to our inventors and authors. The law is not merely an offer to give a United States patent free to every owner of a foreign patent who will exhibit at San Francisco, but it offers him protection far better than the United States patent affords to the ordinary inventor. For while under our present laws the owner of a United States patent or copyright has to find his remedy against infringers by a suit in the civil courts, this legislation

would place the fortunate holder of such a certificate as the law creates in position to appeal to the criminal courts for the punishment of anyone who should infringe his rights. If this remarkable law were to remain on the statute books, then every owner of a valuable United States patnet, (for example, the owners of the patents which are used for what we have termed blackmailing purposes) who holds any foreign patents on the invention would immediately arrange to exhibit at San Francisco, importing the exhibit from a foreign country. He would thereby become entitled to the same remarkable privileges that are under the law granted to other holders of foreign patents and copyrights.

One can imagine the situation into which the engineering profession would be thrown, for example, if every alleged infringer of some of the patents whose validity have been contested in the courts during recent years, was rendered liable to fine and imprisonment. It will be apparent also that while the law would place a most dangerous power in the hands of the owners of patents having large capital at their command, the ordinary inventor would often find it difficult to procure the necessary foreign patents and to arrange for the manufacture of his invention abroad and its importation and exhibition.

It is, however, hardly to be believed that the law will be permitted to remain on the statute books when public attention is once called to its dangerous provisions. A convention of manufacturers, merchants and importers has been called, to be held at the Hotel Astor in New York City on Nov. 21, 1913, to urge the enactment of amendments to the law which will eliminate its dangerous features.

The convention is an outgrowth of the convention of the Federation of Trade Press Associations, held in September in New York City, and the committee appointed by that convention is coöperating with the National Registration League, of Philadelphia, in urging legislation to protect commercial designs by registration in this country. This also will be one of the subjects considered at the convention.

Federal Control of Stock and Bond Issues

At the annual convention of State Railway Commissioners with the Interstate Commerce Commission, held in Washington last week, resolutions were adopted urging upon Congress legislation which would give the Interstate Commerce Commission authority to regulate the stock and bond issues of the corporations under its control. The resolution declared that the Commission should have powers similar to those already possessed by the Public Utility Commissions of New York State, whereby no stock or bond issues may be made without application to and approval by the Commission. The resolution referred to was submitted to the convention by the Committee on Railway Capitalization, and recited that the reason for the resolution was the scandalous misuse of funds by a great railway corporation recently brought to public notice. The following extract from the committee's report is of special interest:

> The finances of all public utilities, but particularly of the tremendous agencies engaged in interstate commerce have been a pawn of the manipulators who are more interested in gain than in the proper service to the public. There these financial magnates sit apart building tremendous fortunes, nominally in control of great enterprises, but really delegating the control to others who are prevented from doing that which they would do by the various financial manipulations of their superiors. The great financial interests and not the active railroad managers have been found responsible for most of the mismanagement of railroad enterprises.

In the same connection it is of interest to note that at the American Mining Congress held in Philadelphia Oct. 20-24, a resolution was adopted calling for stringent state legislation to afford protection to minority stockholders by making directors more definitely responsible for their welfare and making the infraction of such laws a felony punishable by imprisonment. It further urged the Department of Justice to investigate recent scandals regarding securities listed on the New York Stock Exchange.

Twenty years ago, when the states of Texas and Massachusetts stood alone in requiring the approval of a state commission for the issue of stocks and bonds by public utility companies, there was a great outcry that such interference by the state was a step toward Socialism. The resolutions summarized above indicate how far public opinion has traveled since that day. The two organizations whose resolutions are quoted above may be taken as fairly representing the prevailing sentiment of conservative business men. It must be said, too, that this sentiment is the result, not of socialistic agntation, but of the logic of events.

An excellent illustration of the manner in which public opinion of this sort is created is afforded by a private letter written by the head of a prominent banking house in Boston recently with reference to the affairs of a great industrial organization whose conduct by those in control has been the subject of severe criticism. The banker in question said:

> It is such instances as this of mismanagement of large corporations which cause dissatisfaction with the present regime and make men go to extremes in the other direction, and one can hardly blame them for so doing. I do not believe in government ownership of our large corporations; but if things continue the way they have been going during the last few years, I think that the sooner the government takes hold of them the better it will be.

It is noteworthy that at this time, when such emphatic demands as those above quoted are made with respect to public control of security issues, announcement is being made of enormous new bond issues by a number of the leading railway companies. The Pennsylvania, for instance, proposes to issues a blanket mortgage for a billion dollars on its entire property; the St. Paul system contemplates a similar bond issue for $600,000,000; the Erie proposes one for $350,000,000, etc. These figures are staggering.

It is, of course, understood that these totals represent merely the maximum amount for which a mortgage is to be drawn, and that the proceeds are to be issued as required over a long term of years to pay off old bond issues as they mature, and to provide new capital for extensions and improvements. At the same time it may well be questioned whether it is in the interest of either the stockholders or the public that such vast amounts of new capital should be expended by the railways during the next few years as some great financial magnates have demanded. One has only to look back on the expenditures which have been made by railway companies during the last score of years to see many places where money by millions has been poured out to gratify the ambition of a president, or perhaps to furnish huge profits to some

construction company owned by insiders. During the past month an engineer of high standing testified before a state investigating commission that a short piece of railway in New England had cost between $4,000,000 and $5,000,000, when an equally good line could have been built by the expenditure of half the sum expended.

Supervision of security issues by some public authority is demanded not alone to protect the public from the evils of stock watering, but to protect legitimate investors from robbery at the hands of financial pirates.

LETTERS TO THE EDITOR

Proper Crown for Bituminous-Macadam Pavements

Sir—Referring to the letter of J. P. Snow, in the Oct. 16 issue of the ENGINEERING NEWS, I may say that the temptation for making the crown of bituminous-macadam the same as for waterbound macadam pavements is quite strong at times.

As an example, in plans recently prepared for a tar-macadam street a 6-in. crown was specified for a 30-ft. width of pavement. The longitudinal grade varies from 2 to 5%. The contractor and some of the property owners thought that the crown should be 12 in. or more, and the city council was requested to have it so constructed. By special efforts these people were convinced that a 12-in. crown was too high; and the matter was compromised by adopting a 10-in. crown.

The pavement as completed is satisfactory to most of the property owners, but I am convinced that a 6-in. or 8-in. crown would have been far better. The argument was advanced that with a low crown the center would wear and the street would not drain properly to the gutters. Against this argument it may be said that with a high crown the traffic will be more concentrated at the center and consequently the wear at the center will be greater.

PAUL V. HODGES.

Monroe, Wis., Oct. 20, 1913.

Amount of Water Required for Canal Lockage

Sir—On p. 781 of ENGINEERING NEWS of Oct. 16, 1913, I notice this remarkable statement: "The filling of the lock chambers occupied a longer time than normally, because of the small displacement of the tug; in the case of a large vessel, much less water would have been used."

It will be obvious to anyone familiar with canal locking, that the same amount of water is needed for filling a canal lock whatever the displacement of the vessel locked, when it is considered that the vessel displaces as much water in the lock before it is lifted (or at the lower level) as it does at the upper level—unless large quantities of salt are admitted to the lock during the operation. The same quantity of water will also be used when the level in the lock is raised to the upper level if no vessel is in the chamber.

C. T. SCHWARZE.

1123 Broadway, New York City, Oct. 23, 1913.

[We appreciate our correspondent's correction. The news note in which the erroneous statement occurred was abstracted from two recent issues of the *Canal Record*, and the particular statement in question was taken verbatim from the *Canal Record* of Oct. 1.

Mr. Schwarze's explanation becomes perfectly clear if it is remembered that it requires a certain fixed volume of water to raise the water level of the two lock chambers from a fixed low level to a fixed high level. When a vessel enters the lower chamber it displaces and forces out of the lower chamber through the open lower gates an amount of water exactly equal to the vessel's displacement. Hence the level of the water in the lower lock after the lower gates are closed has not been changed, and just as much water will be required to fill the chambers as if the lock had contained no vessel before the gates were closed.—ED.]

An Old Surveyor's Latest Solar Observation

Sir—Did you ever see the Autumnal Equinox? Well, if you haven't, I have; and it was one of the most striking phenomena that has ever pleased my astonished vision.

There are certain things I have heard of during all my long life, but have never seen, and I am naturally skeptical as to whether there are any such things. When I lived in Florida, everybody was wise on the subject of malaria—the poison that affects God's free air at certain hours but not at other times. I used to tell them there was nothing in all that nonsense about foul air being the cause of malarial fever—there must be some other cause. A little later, tardy Science came along with its proofs of insect causes, and my skepticism concerning the false theory was vindicated.

In like manner, I had neighbors down there, good, pious crackers, who didn't want their children taught in school that the earth turned over once every day. A leader among them couldn't see that the earth turned at all. He set a pail of water out on a stump beside his cabin, as a fair test whether the teacher told the truth; and it was right side up in the morning! Hadn't spilt a single drop! So, by experimental and scientific processes, he disproved the theory, so far as it concerned him and his household and water-pail.

In a similar spirit, all I knew about the equinoxes was like mere speculation. They were fine in theory, but I had not really seen them. They could be reasoned out to a demonstration, just as we cannot escape the reasoning that proves a universal flood called ether, in which all the worlds are swimming, and which is thought to conduct "attraction of gravitation" in large or small quantities to order, in every direction, though nobody can find

any of that ether. So I gave up expecting to see the equinox in visible form, though I had toted and regulated a solar transit in some fifteen different states.

But a few weeks ago, on an evening of overcast sky with promise in the west, I casually stepped across our street (East Capitol) just to mail some letters; and when in the center, right between the car tracks, I happened to glance westward, where the vast bulk of the Capitol, three-fourths of a mile away, bounded the vista between the shady elms. There a dazzling spectacle held me spell-bound. The rotunda appeared to be full of the reddest burning Bengal lights that ever blazed. The half-blinding flood burst out through the great bronze doorway, radiating and scintillating with crimson fire. What did it mean? Was that fireproof dome burning? Or was it like the magic light that streamed from the open grave of Michael Scott, the wizard?

While I stood fixed in admiration, gazing at the glory, I reasoned it out thus: Our street was laid out from a true Polaric meridian by Andrew Ellicott, 122 years ago, and its center line runs west to the center of that building and dome. The beautiful red fire I saw was part of the glowing disk of the setting sun, seen through the east and west doors of the rotunda. Since it seemed to set on this line, it may be the time of the equinox—sure enough! I had dated my letters Sept. 22. Then the sun ought to set at 6 p.m., but the watch said six minutes past. All right again; we are two degrees west of the 75th meridian, hence there should be eight minutes allowance for local mean time of Washington. The red blaze became less powerful—it grew dim—and the disk passed below the plain of Arlington at 6:08, standard time. And I had seen the equinox so visibly displayed as to dispel any further skepticism.

And what is more, I had roughly checked the accuracy of Ellicott's line, established four generations ago. My alidade or telescope was the far-off Capitol with its two doors 200 ft. apart; and through that precise sighting-tube 3500 ft. away I had taken observation on my target, the wonderful orb of day, ninety-three million miles distant. The course was exact; the watch was right; the longitude could not be disputed; refraction balanced the elevation of my horizon; the sun was precisely on its job; the Ephemeris was confirmed; and the empty Capitol, where men draw pay without visible presence, was found to be sitting square with the world.

My observation was successful. It reflected credit and glory on Ellicott's survey of the great future city; and on the Capitol; and on me—for I had discovered the Autumnal Equinox, with its search-light streaming through those open doors, like the golden beams from the gates of Paradise, when St. Peter flings them wide open for one of earth's benefactors, such as an honest surveyor.

A. W. BARBER.

703 East Capitol St., Washington, D. C., Oct. 28, 1913.

NOTES AND QUERIES

Another Chart for Proportioning Spur Gears—A chart for determining the power which can be transmitted by cast gears of given dimensions, or vice versa, based upon two-thirds the values calculated by means of Lewis' formula, is sent us by G. F. Dodge, Assistant Engineer, Stone & Webster Engineering Corporation, 147 Milk St., Boston, Mass. Mr. Dodge briefly compares his chart (publisned in the "Iowa Engineer") with that of F. W. James, which appeared in "Engineering News" of Oct. 9, 1913, in Mr. Dodge's chart, only two steps, each of which is made by a right-angle turn, are required for complete solution. The simplicity of this arrangement, he claims, is a distinct advantage, as no special rules of procedure have to be memorized.

Natural Asphalt Deposits of California*

Deposits of bituminous sandstones in California occur principally in Santa Barbara, San Luis Obispo, and Santa Cruz Counties. The fact that the petroleums of California all have an asphaltic base leads to the belief that the natural asphalt was distilled from petroleum deposits.

The asphalt of Carpenteria, Santa Barbara County, has been used for paving purposes for something like 25 years. It is very soft, and is mined by the use of hot shovels. One of the most extensive deposits in the state, known as the Sisquoc deposit, occurs 15 mi. east of Santa Maria, in the same county. Its depth is from 150 to 200 ft. at the summit of the ridge, which extends 600 to 1000 ft. along the major axis. It is estimated to contain no less than 4,000,000 tons of paving material. There are other valuable deposits of natural asphalt, but the most important of them all occurs on the slope of the Coast Range Mountains, eight miles from the city of Santa Cruz. This deposit, owned and operated by the City Street Improvement Co., of San Francisco, Calif., comprises three layers of saturated sand. The lowest is 8 ft. thick and contains 2 to 3% of bitumen; the middle stratum has a depth of 32 ft., and is saturated with about 14% of pure bitumen. The third is a 25-ft. stratum of excellent 16 to 18% bituminous sandstone. The extent of this mine can be appreciated when it is stated that the estimated content is five million tons, capable of covering 500,000,000 sq.ft. of surface 2 in. deep.

The product is obtained by blasting. Each shot, consisting of 175 lb. of black powder, throws up about 300 tons of sandstone in the form of large blocks, which are again blasted and broken up into convenient sizes for handling.

The raw material contains all the ingredients necessary to good paving, but not in the correct proportion. It, therefore, has to be disintegrated by the application of heat and thoroughly remixed before it is in a commercial state. Reduction is accomplished in what is known as a torpedo mixer, consisting of a conical-shaped drum, which revolves above a gas burner. The material is placed within the drum, which is rotated at a speed of about 12 r.p.m. Within the latter is a worm which extends the full length of the drum, and requires 10 to 15 minutes for the material to pass from the inlet to the outlet. The operation is much the same as that of a rotary concrete mixer.

This material has been thoroughly tried out in actual service. There is a pavement of natural asphalt on State St., Santa Barbara, which has been used for 27 years. "N" St., Sacramento, from 10th to 15th Sts., was paved with Santa Cruz bitumen in 1906 and is good for 50 years more. Sections of Fell St., San Francisco, and Virginia St., Vallejo, which have withstood 20 years of service, are further proof of the durability of this material.

*Abstract of article by J. R. Price, in the "California Journal of Technology," August, 1913.

A Typical Hamburg Quaywall

One of the latest pieces of the extensive municipal seawall construction work in Hamburg, Germany, was done last year at the slip alongside the yard of Blohm & Voss in order to make this slip available for steamers of the "Imperator" class during the finishing work after launching. Since the improvement the hull of the giant "Vaterland" has occupied the slip. The slip had to be deepened from 25-ft. depth to 33-ft. depth at mean low-water. Partly for this reason and partly because the existing

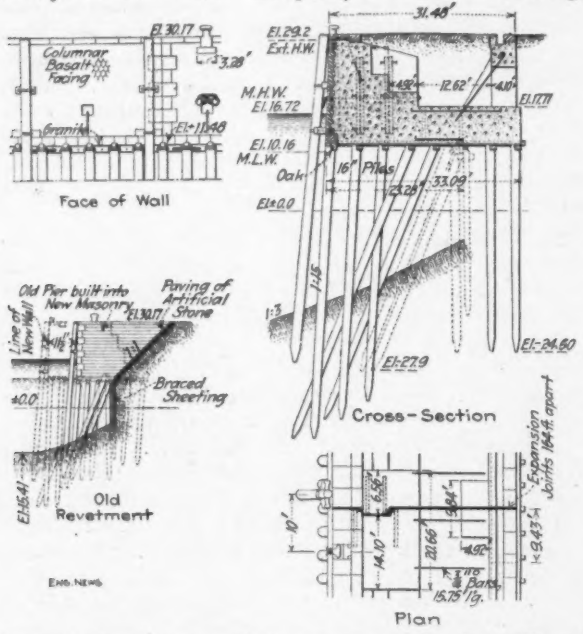

FIG. 1. QUAYWALL AT HAMBURG FOR 33-FT. LOW-WATER DEPTH

quaywall was of unsuitable kind, the entire quaywall had to be rebuilt. At the same time the shipbuilding firm put up a 275-ton tower crane on the quay, its foundation being independent of that of the wall.

The wall is shown by the drawings, Fig. 1. A small sketch of the old wall, indicating the relative positions of old and new wall, is included in the drawing. The old wall consisted of masonry piers 82 ft. apart and intermediate sections of sloping bank paved with cement blocks, over a footwall of braced piles set close. The new wall is a concrete base slab and front wall for retaining the fill, resting on pile and grillage foundation. The masonry work was done in the open, and, therefore, the top of grillage is fixed at 1.7 ft. above low water.

The extreme tidal range at Hamburg is from 2.35 ft. up to 28.5 ft. above Hamburg Datum, but the ordinary range is only 6½ ft., from El. 9.8 ft. to El. 16.4 ft. The desired low-water depth is 10 m., requiring the slip to be deepened to El. —23 ft. (—7.0 m.). The mean high-water depth, therefore, is 39.4 ft. As will be seen from the sketch, the elevation of top of quaywall (9.2 m.) is just above extreme high tide and gives a freeboard of about 20 ft. at mean low tide.

The use of pile-and-grillage substructure is the standard for quaywall work in Hamburg, this practice having prevailed now for a considerable time past. The piles are 16 in. butt diameter, and average about 4½ ft. spacing. They are capped by longitudinal 8x10-in. caps and over these is an 8x9½-in. cross-sill over each transverse pile row. The longitudinal caps are notched into the pile top and bolted through. A 2-in. plank floor is laid over the caps between cross-sills, and on this the concrete and stone facing work is erected. The timber is all fir, except that the cap of the front row of piles is oak.

The concrete of the body of the wall is 1:8 mixture (cement and gravel). The front of the wall is faced with blocks of columnar basalt, which are quite regular in shape and make a neat and very durable facing. This is also a standard detail in Hamburg quaywall construction.

At the rear of the base slab there is a backwall for carrying the rear truck of a gantry crane running along the quay; in fact, provision for this crane track was the reason for making the grillage and base slab as wide as shown. Longitudinally the crane has a wheel base of 79 ft. Its total loaded weight will be 1100 tons. The longitudinal slot in the top of the backwall, seen in the cross-section, is the conduit for the electric cables supplying power to the crane.

The cost of the quaywall was approximately M1900 per lin.m., or $140 per lin.ft. This is lower than the normal cost of such a structure by about $45 per lin.ft., on account of the presence of the old revetment.

To give some basis of judging of the above cost figures, it is noted that the cost of the foundation piles in place (i.e., driven) is as follows:

Average diam of pile	Cost in place, per lin.ft.
20 in.	$0.95—1.10
18 in.	0.80—1.00
16 in.	0.75—0.95
14 in.	0.60—0.75

The concrete (1 to 8 mixture) cost $3 to $3.50 per cu.yd. The coping granite cost about $33 to $37 per

FIG. 2. THE 250-TON WHARF CRANE IN BLOHM & VOSS' SHIPYARD AT HAMBURG, GERMANY

(Steamship "Vaterland," largest in the world, is lying in the slip, being completed.)

cu.yd., in place. The average rate of pay of concrete workers is about 19c. per hr.; masons and carpenters are paid 6c. to 7c. more.

The 275-ton fixed tower-crane already mentioned was shown in outline sketch in our issue of Oct. 31, 1912. Its appearance is reproduced more strikingly by the view Fig. 2 herewith. The long or front arm of the crane can tilt upward, being operated by a pair of pulling screws attached to links in the line of the top chord. The load of

275 tons (250 metric tons) can be carried at a radius of 105 ft. from the center. The small locomotive crane running on top of the arm has a capacity of 22 tons at half projection, or 11 tons at full projection of 52½ ft. from its own center, which makes the extreme reach 229½ ft. from the center of the tower. The top chord of the main crane is about 180 ft. above quay level. The drive of the crane is wholly electric, the control being of the Leonard type.

A Cableway for Railway Lumber Cars

By M. M. Cooke*

The highest and longest single-span cableway in the United States is located across the south fork of the American River in El Dorado County, Calif. It is owned and operated by the C. D. Danaher Pine Co., successor to the El Dorado Lumber Co., which erected the line in 1901, and it is employed to transfer cars of lumber between two logging railroad terminals on opposite sides of the cañon.

Cableway for Transporting 8-Ton Cars of Lumber across the 2250-Ft. Canyon of the South Fork of the American River, El Dorado County, Calif.

The timber is felled in the forests on the north side of the river in the vicinity of Pinogrande, and is cut into lumber by a sawmill at that point. The lumber is then loaded into narrow-gage steam railroad cars and transported to the brink of the cañon about ten miles distant from the mill. The cars are then transferred, one by one, across the chasm by means of the cableway; a train is made up on the south side of the river from whence it is run to the planing mill at Camino, about eight miles. Here the lumber is passed through the planer and loaded into standard-gage cars and shipped to dealers.

The accompanying illustrations give some idea of the arrangement of the plant and the relative sizes and general appearance of the cage and cars. The distance between the cableway supports is 2250 ft., and the height from the river bed approximately 1500 ft. The sag in the cables under a 10-ton load is approximately 150 ft., and the difference in elevation of the two stations is 37 ft., the one toward which loaded cars move being the lower. The time of transit between stations is 1½ min.; and the time required to make one complete round trip, including the transfer of a loaded and empty car, is 7½ min.

The two-track cables are 1½ in. in diameter and consist of 57 strands ($\frac{5}{32}$-in. diam. each) of tempered plow-steel wire wound on ½ spring-steel core, each cable having a breaking strength of 125 tons.

The average car of lumber handled has a gross weight of about 8 tons and an average of 60 cars are handled daily. The heaviest load to which the cables are subjected is the occasional transfer across the cañon of a 10-ton Shay-geared locomotive.

As the cables wear, and one by one the strands part, each wire is unwound from end to end of the cableway and removed. This precludes the possibility of the broken ends of the strand causing the trucks of the cage to leave the cable. When 7 strands of the 57 are thus removed the cable is discarded and a new one takes its place. During the twelve years' life of the plant the west cable has been renewed twice and the east cable only once. These cables are anchored into the solid rock at both stations, and the tension in each is adjusted by means of a tension screw, 12 ft. in length, so arranged that the cable may be clamped while the screw is being reset.

The traction cable is an endless ¾-in. wire rope with a hemp core and is renewed each year. The cage constitutes the closing link to which the wire rope is permanently attached. On its return the haulage cable, guided by two horizontal sheaves at each station, travels outside of and considerably above the line of the track cables. Owing to the unfavorable configuration of the ground surface, the power-house is located about 15 ft. off the line of the cableway, thus causing the haulage cable to pass around additional sheaves at two angle points.

The cage is 7 ft. wide by 12 ft. long by 10 ft. high, built of light structural steel, is partially floored, not roofed, with the sides boarded up about 4 ft. from the bottom. It is suspended from two 4-wheel (30-in. diam.) trucks traveling on the track cables. The ends of the cage are open. The lumber is clamped to car and car axles are clamped to cage. The cars are handled into and out of the cage at each station by a one-horse snap team. At the south station the cableway makes such a sharp angle with the wall of the cañon that it is necessary to turn the cars through about 70° on a turntable before they can be shunted down the make-up track.

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The cableway supports on either side of the cañon are practically alike in design. Each is constructed of two lines of 9 each double 12x12-in. timber posts, each bent braced outside with 12x12-in. batter posts and double-sway braced from top to bottom with 6x8-in.x4-ft. timbers, and the two lines transversely braced with 10x12-in. timbers. The cables rest in cast-iron saddles bolted to 12x14-in. caps which are in turn dapped and bolted into the tops of the vertical posts. The entire structure is housed-in and roofed, and is two stories in height. The lower floor provides ample room and clearance space to permit a man to stand upright while clamping the car axles to cage.

The power-house is located on the south side of the cañon about 100 ft. distant from the tower and 15 ft. off the line of cableway, as mentioned previously. The plant is operated by two 17x34-in. cylinder steam engines connected together, working as twins and reversible. The two are not twins, however, as one was built in San Francisco in 1865 and operated a sawmill over 30 years before being installed in its present location. The other is a newer machine but bears no name plate. Steam is delivered from an Ames return-tube 100-hp. boiler using slat wood for fuel.

The main shaft (6-in. diam.) is driven by a 15-in. crank with a 7-ft. connecting rod, and carries an 83-in. diam. friction brake operated by hand. A 50-in. diam. steel-geared wheel on the main shaft works into a 72-in. hard-maple cog wheel on an 8-in. countershaft which carries the main sheave (78-in. diam.) on which the haulage cable is wound twice. The cable is also wound over on a 61-in. sheave forward, which drives a horizontal indicator by means of a worm gear.

The power-house is so situated that the engineer is unable to see the cage at any part of its journey and is guided entirely by the indicator and a system of electric-bell signals operated from each station. He operates through levers, the throttle, handbrake and reverse lever.

The company does not make a practice of handling passengers, though certain of its employees are transferred back and forth every day; and during the twelve years the cableway has been in operation it has never experienced a serious accident. The cost of operation is about $25 per day.

Interlocking Plant Moved without Interrupting Operation—To accommodate some track changes, an interlocking plant, with tower 52x14 ft. in ground plan, was moved laterally about 8 ft. last winter at Kray, in western Germany, without interrupting operation in any respect. A passing-track was to be laid between the existing main-line tracks, and these could be spread only toward the side where the tower stood. The expense of tearing out the old plant and building a new one in the new location led to the decision to move the old tower but the heavy traffic made it undesirable to rely on hand signaling during the moving. The plant was wire-connected throughout, and with one exception the wires ran out parallel to the track. The required distance of the moving of the building being not very great, the wire connections did not have to be extended, as the compensators could furnish the slight additional length. The preparations for the actual moving were similar to those commonly employed in moving buildings. Steel I-beams were used as needles and as roller tracks; 3-in. solid steel rollers were used. The moving was done with rope tackle hitched to the front end of the track beams. The new foundation was built before moving began. Actual moving occupied less than 1½ hours, and during this time the switch and signal service went on as usual from the tower. The cost of the operation was less than $1000. The operation is described in some detail by Baurat Niemann, of Magdeburg, in "Zeitschrift des Vereines deutscher Ingenieure," Oct. 4, 1913.

The 33,500-Hp. British-Built Steam Turbine of the Commonwealth Edison Co., Chicago

The proposed installation of a 25,000-kw. steam turbine to be built by C. A. Parsons & Co., of Newcastle-on-Tyne, England, was briefly noted in ENGINEERING NEWS, Apr. 18, 1912, shortly after the contract was let. The novelty of imported machinery of this character and magnitude, and the interest in details of construction for a steam turbine of this size and guaranteed steam consumption have kept the project a live topic in engineering circles. The installation is under way and the following information has recently been secured from the purchaser, the Commonwealth Edison Co., of Chicago, through their consulting engineers, Sargent & Lundy, of Chicago, and from the turbine builders.

This generating unit is the largest prime mover yet assembled on a single shaft, though it is not as large as machines soon to be installed in Chicago, Philadelphia and New York City. The turbine is designed to develop maximum economy at 20,000 kw. generator output but it has a continuous capacity of 25,000 kw., and a short overload capacity of 10% additional to care for momentary load fluctuations.

At a speed of 750 r.p.m. with steam at an initial gage pressure of 200 lb. per sq.in. and 200° F. superheat, and with a 29-in. vacuum at the condenser, the guaranteed steam consumption is as follows:

At 10,000 kw.—12.50 lb. per kw.-hr.
At 15,000 kw.—11.65 lb. per kw.-hr.
At 20,000 kw.—11.25 lb. per kw.-hr.
At 25,000 kw.—11.65 lb. per kw.-hr.

These figures include losses for generator excitation but not the energy for forcing cooling air through the generator. It is reported that there is a penalty of $2500 for each ¼ lb. steam consumption over the 11.25 lb. guaranteed and an equal bonus for improvement.

POWER-STATION CHANGES—This machine is to be installed in an extension of the Fisk St. Station, as noted in ENGINEERING NEWS, Apr. 18, 1912, where there will be an ultimate equipment of 210,000 kw. This station is one of three large ones to give the company generating capacity of 454,000 kw. out of its 480,000 total. These other stations are the Quarry St., built in 1908, and having a projected equipment of 84,000, and the new Northwest Station to have a total ultimate capacity of 160,000 kw. as described in ENGINEERING NEWS, Apr. 3, 1913.

As shown in our previous notes, improvements in the power-station art enabled a considerable saving of room over the original plans for the Fisk St. Station in Chicago. This space is now being utilized in an extension to house this Parsons turbine and other generating equipment, prominent among which will be a 30,000-kw. horizontal Curtis turbine unit for which order has recently been placed and a 20,000-kw. horizontal Curtis unit now being installed.

To supply the new Parsons turbine, four marine-type water-tube boilers, having each 12,200 sq.ft. of heating surface and 20% of superheating area, are being added. The boilers have chain-grate stokers and are designed to evaporate 80,000 lb. water per hour continuously, under 210 lb. normal gage pressure (225 lb. maximum) and 225° F. superheat. For each boiler there is an economizer (8500 sq.ft. heating surface) with induced-draft equip-

ment for moving 80,000 cu.ft. of air per minute and maintaining 1½-in. draft in the boiler uptake. Coal will be brought by conveyors to bunkers over the boiler, there being storage for about 225 tons per boiler here with 4680 tons extra storage capacity for the unit in the train shed and receiving hoppers.

Turbine Design—Fig. 2 shows a high-pressure and low-pressure turbine with shafts rigidly coupled in line to form a single unit. These drive, through a flexible coupling of the Parson's claw type, an alternating-current generator and, at the extreme end on an extension, the exciter for this. The overall length of the complete unit is 76 ft. 2 in. The maximum width is 18 ft., and the height from base of condenser to the highest point on the unit is 30 ft., of which 20 ft. is under the floor level.

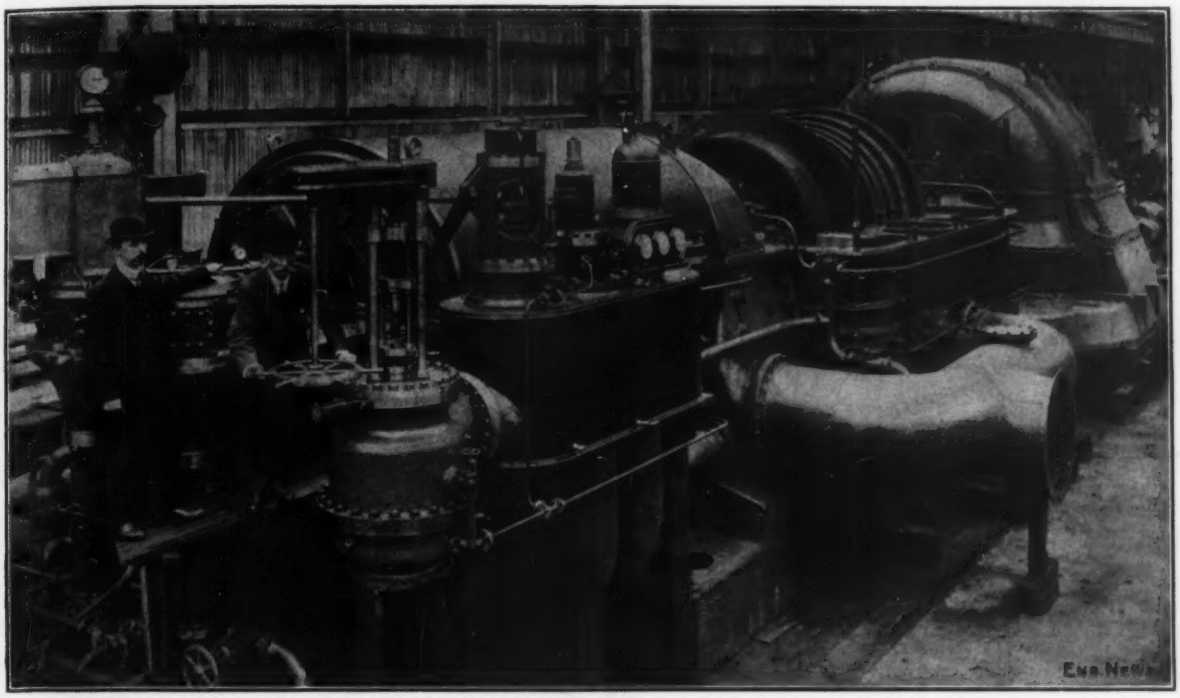


Fig. 1. A 25,000-Kw. Parsons Steam-Turbine Generating Unit
(Upper half of low-pressure turbine removed to expose rotor.)

The high-pressure section is a single-flow turbine of standard Parsons' type. There are six expansion stages with 64 rows of blades. The end pressure is balanced by three dummy pistons. This half of the turbine unit is designed for a little less than half the total load of the unit. The rotor drum is of forged steel, the shaft at the steam-inlet end being solid with this. At the exhaust end, the drum is shrunk on and securely bolted to the forged steel shaft which carries the drum of the low-pressure turbine. This construction is resorted to, it is stated, to prevent possible relative movement due to changes of temperature.

The blading in the high-pressure turbine ranges from 2¾ to 6½ in. in length for the six stages. Each blade is calked in separately with its spacing piece. The high-pressure casing is built up in four sections, two above and two below; the material is cast steel on account of the high temperature of the superheated steam.

Steam at a pressure of about 25 lb. absolute passes from the exhaust of the high-pressure section through two 30-in. diameter pipes leading to the central chamber of the low-pressure turbine. This is a double-flow type with six expansion stages for each side, as shown in Fig. 2. Steam finally reaches the condenser directly below through a rectangular orifice 21 ft. long by 12 ft. wide.

The low-pressure-turbine drum is supported on the shaft at three places. The supports at each end take the form of expansion joints, each consisting of a flanged diaphragm of mild steel, with the flange fitted to the interior of the drum and the web held between two rings on the shaft. The faces of these rings are corrugated to insure a good grip after riveting. At the center of the drum is a steel casting to give additional stiffness where the blades are shorter and maintenance of small clearances important. The blading in both high- and low-pressure sections is known as the "separate reaction" type and is held in the drum by single or double calking, according to the height of the blade and the depth of the groove. The heights range from 2¾ to 19 in. The high-pressure turbine blades are of copper, but the low-pressure blades are of brass. All blades throughout the combined unit are thinned down at the tip and reinforced by binding strips.

At each end of the low-pressure turbine are steam-packed glands, steam being supplied to them from the exhaust of the governor relay. The low-pressure turbine casing is of cast iron throughout, weighing about 150 tons. The top is built in two sections and the bottom in four. The high- and low-pressure casings are rigidly coupled together, and longitudinal expansion is provided for at the inlet end of the high-pressure turbine where the foot of the casing rests on a pedestal between stripper side guides.

The governor operates on the familiar pulsating-admis-

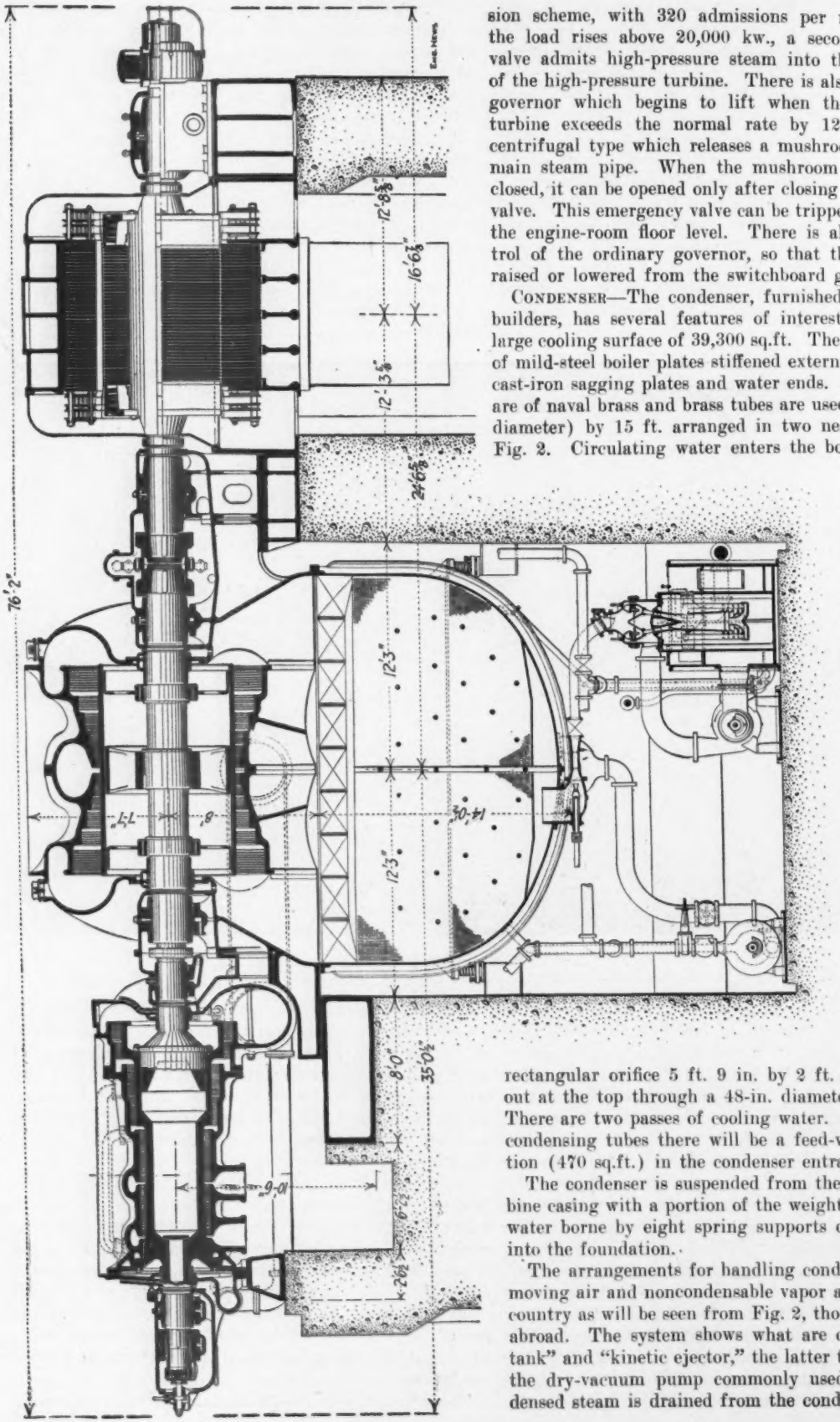


FIG. 2. SECTIONAL ELEVATION OF 25,000-KW. STEAM-TURBINE UNIT AND CONDENSER OF THE COMMONWEALTH EDISON CO., CHICAGO

sion scheme, with 320 admissions per minute. When the load rises above 20,000 kw., a secondary governor valve admits high-pressure steam into the second stage of the high-pressure turbine. There is also an emergency governor which begins to lift when the speed of the turbine exceeds the normal rate by 12%. This is a centrifugal type which releases a mushroom valve in the main steam pipe. When the mushroom valve has been closed, it can be opened only after closing the main steam valve. This emergency valve can be tripped by hand from the engine-room floor level. There is also electric control of the ordinary governor, so that the speed can be raised or lowered from the switchboard gallery.

CONDENSER—The condenser, furnished by the turbine builders, has several features of interest aside from its large cooling surface of 39,300 sq.ft. The shell is built up of mild-steel boiler plates stiffened externally, and having cast-iron sagging plates and water ends. The tube plates are of naval brass and brass tubes are used 1 in. (external diameter) by 15 ft. arranged in two nests as shown by Fig. 2. Circulating water enters the bottom through a rectangular orifice 5 ft. 9 in. by 2 ft. 2 in., and passes out at the top through a 48-in. diameter discharge pipe. There are two passes of cooling water. Besides the main condensing tubes there will be a feed-water heating section (470 sq.ft.) in the condenser entrance.

The condenser is suspended from the low-pressure turbine casing with a portion of the weight of condenser and water borne by eight spring supports on steel beams set into the foundation.

The arrangements for handling condensate and for removing air and noncondensable vapor are unusual in this country as will be seen from Fig. 2, though more common abroad. The system shows what are called the "kinetic tank" and "kinetic ejector," the latter taking the place of the dry-vacuum pump commonly used here. The condensed steam is drained from the condenser by a hotwell

pump and is discharged into the "kinetic tank." From this, a "kinetic pump" takes water and forces it, at a pressure of 40 lb. per sq.in., through a set of water jets (annularly arranged above the "kinetic tank"), spouting across an entrainment space connected with the lower part of the condenser steam space. The nozzles discharge into the tank where the air is released to bubble up and escape through a vent. There is a steam jet connected in the vapor pipe between the ejector nozzles and the condenser, to serve as a vacuum augumenter.

The so called "kinetic tank" has two other compartments, besides an outside chamber and a regulating reservoir—all of which are not directly related to maintenance of vacuum. On one side is a compartment serving as a feed-water heater (provided with steam jets drawing exhaust steam from the high-pressure turbine or from the steam-driven boiler-feed pumps. On the other side is a compartment which takes the place of a hotwell.

The condensed steam flows from the middle compartment, or "kinetic tank" proper, through an outside chamber with copper screens, to the heater compartment and thence to the hotwell section. Should the discharge of condensed steam momentarily exceed the demand of the boilers the excess flows directly from the "kinetic tank" to the reservoir; a float-controlled connection admits water from this supply to the hotwell section when the level drops therein. There is a float in the reservoir tank controlling a valve on the station filtered-water supply, so that the level never drops below a fixed minimum.

ALTERNATOR—The conditions under which this generator had to be designed were unusual. The continuous capacity of 25,000 kw. and the speed of 750 r.p.m. necessarily involved a comparatively large and heavy machine. There were, however, limits of weight and dimension to the various parts on account of transportation. The heaviest part of the whole turbine unit is the lower half of the stator frame, which weighed 60 tons as packed.

The rotor (four-pole field) is a slotted-core type with 32 forged-steel disks mounted on a forged shaft. The coils are form wound, and where imbedded are pressed into leatheroid troughs and secured with brass keys. The total rotor weight is 110,000 lb.

The stator carries a three-phase star winding, with windings of two phases carried across a horizontal magnetic joint. At this point the conductors each have bolted connections to facilitate removal of the upper half of stator. The frame, of cast iron, has four sections, the top and bottom halves each being formed by permanently bolting two sections. The core has 44 groups of thin iron stampings, the groups being separated by ventilating spaces. The core is 92 in. long, and has a 75-in. bore. In 84 completely closed slots ($4\frac{1}{2}$x$1\frac{3}{16}$ in.) is a bar winding of one conductor per slot. Bar-end connections are of copper strip. The machine is completely inclosed by cast-iron end shields which form conduits for the cooling air. Provision is made for 80,000 cu.ft. of air per min. to insure a rise of less than 70° F. A 150-hp. motor-driven fan will be installed below the generator.

The machine generates at 4500 volts, 25 cycles. As the potential of the main station busbars is 9000, step-up compensating transformers are to be installed between generator and bus.

The exciter is an ordinary four-pole, 250-volt, self-excited, shunt-wound generator. The field frame is carried on an extension of the alternator outer-bearing pedestal.

This unit was built at the Heaton Works of C. A. Parsons & Co.; the condenser shell was furnished by R. & W. Hawthorn, Leslie & Co., Ltd.; the "kinetic ejector" was furnished by Richardsons, Westgarth & Co., of West Hartlepool, England, but the condenser auxiliary and boiler-feed pumps are from H. R. Worthington, of New York. Associated with the consulting engineers of the Commonwealth Edison Co. (Sargent & Lundy, of Chicago) have been Messrs. Merz & McLellan, of London.

Preventing Accidents by Recording Dangerous Conditions*

To decrease the number of accidents, two factors must be considered: (1) The simple exercise of judgment on the part of men who can reason; (2) the less patent one which has to do with unforeseen happenings. A wreck may occur on a railroad either as the result of an open switch or of a broken rail; the first falls within the range of readily preventable accidents, while the second probably could not have been foreseen. The development of the multitude of safety devices has not reduced accident percentages materially because the personal factor—the anticipation of the results of certain conditions which may arise—has not been emphasized properly. The man in charge is the one whose duty it is to anticipate possible injury by providing proper safeguards.

The author believes that the supervisors of a plant should regularly note in a memorandum book any current condition or happening which might have led to an accident and how this can be eliminated. It would be well to provide these men with printed forms for this purpose. Analysis of such reports stretching over a sufficient period would indicate just what safeguards the plant lacked.

Everything possible should be done to keep the supervisor of the plant alive to the importance of decreasing the chances for accident, and to adopt safety devices wherever practicable, but not to depend upon these devices to the exclusion of eternal vigilance on the part of those engaged in hazardous work. It is true that this makes an extra load to carry, but one which humanity requires and selfish interest demands.

Baking the Paint upon Passenger Cars in order to dry it quickly is a comparatively recent application of a process long in use in other directions. Two papers upon this subject were presented before the 44th annual convention of the Master Car and Locomotive Painters' Association held in Ottawa, Canada, Sept. 9, 1912. The Pennsylvania R.R. has installed in Altoona, Penn., an oven of sufficient capacity to contain their largest car. This oven, which is 90x13 ft., by 15 ft. high, is heated by steam coils which have a heating surface of over 2700 sq.ft., and has, on occasion, been raised to a temperature of 305° F. It is estimated that this temperature can be reached, without deleterious effect to the paint within 2½ hours. By means of this quick-drying process two cars can be completely painted in 6½ days, as against 13-16 days with the air drying system. J. W. Lawler, Chief Chemist, Pullman Co., claims that baking prolongs the life of paint on steel, renders it more adhesive and gives it greater resistance against moisture. The Hudson & Manhattan R.R. has tried baking the interior of a car by means of suspended electric heaters, the doors and windows being closed.

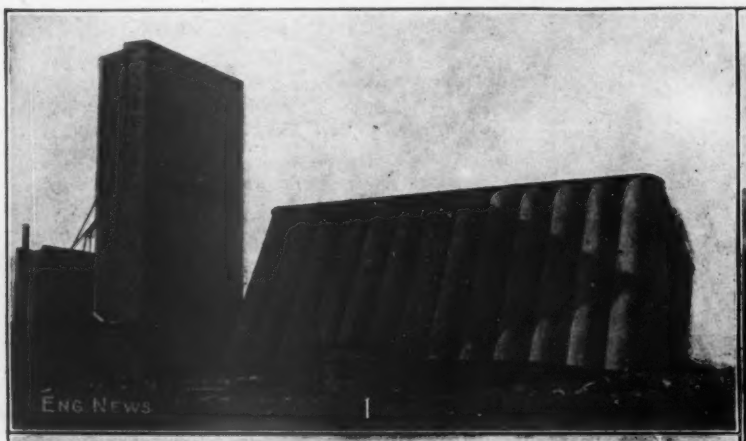
Other matter on this subject was published in "Eng. News," Oct. 3, 1912, Feb. 13 and May 8, 1913.

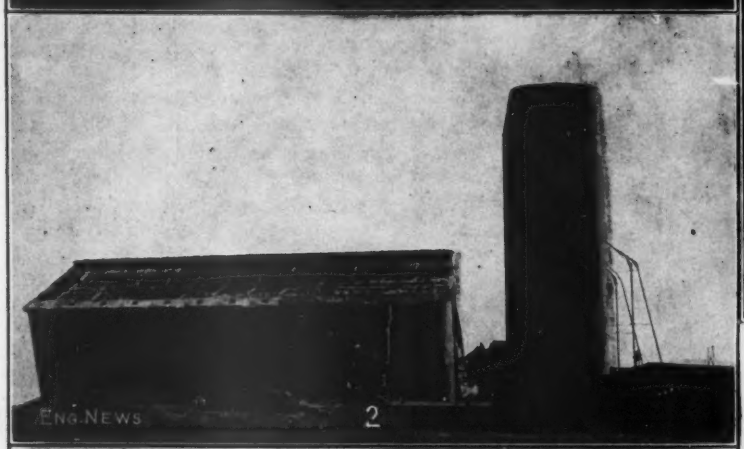
*Abstract of paper by Thomas D. West, of Cleveland, Ohio, read at the annual convention of the American Foundrymen's Association, at Chicago, Ill., on Oct. 16, 1913.

Failure of the Transcona Grain-Elevator

The remarkable foundation failure of a Canadian Pacific Ry. elevator at Transcona, near Winnipeg, briefly reported in our last issue, is made clear by the four photographic views herewith reproduced, for which we are indebted to the courtesy of J. G. Sullivan, Chief Engineer of the Canadian Pacific Ry., Winnipeg, Man. The reinforced-concrete binhouse settled into the ground by the crushing out of the foundation subsoil, and at the same time tilted to the position shown. The movement was slow, taking 24 hr. in all. The displacement of the underlying strata of earth is well shown by the upheaved ridges of earth around the elevator. The detail view, Fig. 4, gives some idea of the surface disturbance. This shows the ridge along the east of the binhouse, seen sharply outlined in Fig. 1.

The elevator was built in the summer of 1912. It consists of a working-house, seen in the views standing undisturbed just south of the displaced structure, and a reinforced-concrete binhouse. The latter consisted of 65 circular bins of 14 ft. 4 in. inside diameter and 90 ft. deep, arranged in five rows of 13 bins each (5 along the working-house, 13 in the direction at right angles to it). The 48 interspaces between the circular bins were also used for grain storage. The binhouse was 10 ft. north of the working-house, and structurally distinct from it, being connected with it only at the conveyor level, just above





SETTLEMENT OF THE TRANSCONA 1,000,000-BU. GRAIN ELEVATOR

FIG. 1. VIEW LOOKING SOUTHWEST

Working-house undisturbed though only 10 ft. from the binhouse. The openings halfway up were connected to the binhouse cupola by conveyor bridges. The ridge of earth in front of the house is the result of the subsurface flow of soil.

FIG. 2. WEST SIDE OF THE ELEVATOR; BIN TOPS AFTER CUPOLA SLID OFF

The view shows the 30-ft. subsidence on this side; the whole length of the binhouse settled practically uniformly.

FIG. 3. SOUTHWEST CORNER OF BINHOUSE, SHOWING SIDE OF GREATEST SUBSIDENCE

The wreckage of the cupola and roof lies at the foot of the house.

FIG. 4. DETAIL VIEW ALONG EAST SIDE, WITH ADJACENT SOIL UPHEAVED (SEE FIG. 1)

the top of the bins, where the conveyor which operates in the low cupola over the binhouse is carried across to the working-house. The principal machinery floors of the working house are above the conveyor level.

The soil at the site is soft clay ground. Rock is 45 to 50 ft. below the surface. The binhouse was founded on a reinforced-concrete slab, 77x195 ft., about 12 ft. below the surface of the ground. In excavating for the construction of this foundation, the upper five or six feet of ground were found rather soft. Below this, however, a fairly stiff clay was struck. Load tests were made at the time, and they indicated that the soil was well able to bear a load of 4 to 5 tons per sq.ft. The maximum loaded weight of the binhouse averaged a little over 2½ tons per sq.ft. The foundation was put in during July, 1912, and the soil was perfectly dry, with no indication of water. Barnet-McQueen Co., Ltd., of Minneapolis, designed and built the elevator.

Rafts or floating foundations of the kind used here are commonly used for elevator foundations in the Winnipeg territory. The working-house of the present elevator rests on a similar slab foundation.

The occurrence of the accident is described as follows: On Saturday, Oct. 18, between 11 and 12 a.m., the elevator then being practically full, movement was noticed on the bridges between the working-house and the binhouse. By 1 p.m. the binhouse had settled about 1 ft. The ground for a distance of 25 to 30 ft. on the north, west and east sides of the binhouse heaved up 4 or 5 ft. In the afternoon the settlement became a little more rapid on the west side, producing a list to the west. The building continued to settle and list for about 24 hours, until noon, Sunday, Oct. 19. Its final position is at an angle of about 28° from the vertical. The east side of the house is raised about 5 ft. above normal level, while the west side is some 30 ft. below normal. The conveyor cupola and roof structure slid off the binhouse when the tilt became too great, which occurred about midnight Saturday.

The structure of the binhouse shows practically no damage in its visible part, except for a few small hair cracks.

The question of saving the grain in the elevator occupied first attention. The binhouse held nearly its full capacity of a million bushels. The bins were tapped through the sides and a temporary conveyor erected alongside for taking the grain to railway cars, and the removal when started progressed at the rate of about 40 carloads a day. It was feared at first that ground water would enter the bins at the bottom and would wet the lower part of the grain. This was found not to be the case, at least during the earlier stages of the transfer. The absence of water is held to indicate that the accident is not chargeable to wet condition of the subsoil. The above statement of facts is based on information furnished by Mr. Sullivan.

Attention is called to the very similar settlement of two reinforced-concrete warehouses in Tunis some years ago, described in ENGINEERING NEWS of Apr. 25, 1907, page 458. The two buildings there which settled were also on reinforced-concrete slab foundation. The maximum subsidence on one side in that case amounted to ten or twelve feet. It proved possible to right the buildings by loading the high side and doing some excavating underneath. In final restored position the buildings were about 15 ft. below their original level.

Twelve Inches of Rain in Twelve Hours at Galveston

BY A. T. DICKEY*

On Oct. 22, 1913, there was a total precipitation of 12.19 in., at Galveston, Tex., of which 12.16 in. fell between 8:43 a.m. and 8.43 p.m. The rain began at 7:20 a.m. and ended during the night about 10.15 p.m.

The maximum amount which fell in one hour was 5.32 in., from 10:32 to 11:32 a.m.

Other heavy rains in the last forty years have been as follows:

14.35 in. in 24 hours, July 13-14, 1900.
14.10 in. in 24 hours, Oct. 7-8, 1901, of which 10.60 in. fell in 5 hr. 20 min.
9.23 in. in 24 hours, on Apr. 22, 1904, of which 8.71 in. fell in 2 hr. 35 min.
6.28 in. in 1 hr. 48 min., on Oct. 6, 1910.

There have been numerous short heavy rains, of which the following is a sample: 1.02 in. in 15 min. on Oct. 15, 1903.

The rain of Oct. 22, 1913, did very little damage in the city of Galveston, except through the cessation of business during the downpour. The streets were damaged on unprotected slopes in the amount of about $2000, and considerable damage was done to merchandise stored on floors below high-water mark.

All streets in the business section were dry within six hours after the cessation of rain and the streets in the lowest and unpaved portion of the city were dry within 24 hours after rainfall ceased.

NOTES FROM THE ENGINEERING SCHOOLS

CHARLOTTENBURG TECHNICAL COLLEGE—A special course in stone testing is being given there this fall. In an announcement from the department of mineralogy and geology of this school, Professor Hirschwald states that the purpose of the course is to give officials and operatives of testing laboratories opportunity for becoming familiar with the practical details of carrying on the Hirschwald system of stone tests. This system was brought up before the International Association for Testing Materials at its New York congress, September, 1912, by Professor Hirschwald, and the Association subsequently resolved to ask the testing laboratories of the different countries to study and try out practically the method in question. The course which the Charlottenburg School will give is to extend three months. Professor Hirschwald, Berliner strasse 171, Charlottenburg, Berlin, Germany, may be addressed for further particulars.

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The Water-Works System at Moline, Ill., is under investigation with a view to extension and improvement. The consumption has grown until the capacity of the present filter plant has been nearly reached, but with the heavy per capita consumption of 250 gal. daily there appears to be an opportunity for using the present supply more economically. A piezometric survey is to be made to determine how the water is used, or wasted, and the results of this survey will be a basis for decision whether to conserve the present supply or to enlarge the filters and other works. This investigation is being conducted by the W. S. Shields Co., consulting engineers, of Chicago.

*City Engineer, Galveston, Tex.

The German Ship "Kalymos" Caught Fire at sea and was reported to have been abandoned on Oct. 31. The crew was taken on board the British cruiser "Cumberland."

A 10-In. Rainfall in San Salvador on Oct. 27 and 28 caused the drowning of 54 persons. The low-lying land was flooded and much property destroyed.

Benzine Fumes in a Tank Car Were Ignited when two employees of Proctor & Gamble, of Ivorydale, Ohio, entered with a lighted lantern, on Oct. 23. The men were severely injured.

A Municipal College at Akron, Ohio, has been provided by the taking over of Buchtel College by the city, under a provision of the new city charter. The plant and endowment thus taken over are valued at $400,000. The charter provides that the board of directors shall be appointed by the mayor. Coöperative courses in engineering are proposed, modeled on those at the University of Cincinnati. P. H. Kolbe is president of the institution.

The Employment Bureau, which was established by the Engineers' Club of Philadelphia, a few months ago, has proven a distinct success, according to the Secretary. No charge is made for the services and the bureau is open to nonmembers as well as members, its object being to benefit all the members whether they are employers or employees.

Federal Coöperation in Fire Protection—The Secretary of Agriculture has just signed an agreement with the State of West Virginia for coöperative protection of the forests of the state from fire, as authorized by the "Weeks Law" where states have a fire-protection system and will expend a sum equal to the federal appropriation. Patrols will be established in the danger districts of the watersheds of the Potomac, Monongahela, Little Kanawha and Great Kanawha rivers. Telephone-connected lookout stations will be established at prominent points. The state will thus expend $5000 a year from its $10,000 appropriation for forest and fish and game protection and the federal government a like amount.

Reconstruction of Chicago Sewers in the downtown district is now under consideration. The present sewers are largely old and of insufficient capacity, and the combined system is used, while the separate system is proposed for the new sewerage system, with a view to the possibility of future requirements for treatment of the sewage. The council committee on streets and alleys has held public meetings for the discussion of the subject, at which engineers representing the city and sanitary district have presented their views. Other meetings are to be held later. Intercepting sewers are to be built to connect the north shore residence towns with the north-shore canal of the Sanitary District of Chicago, thus diverting the sewage of these towns from the lake to the main drainage canal.

A Course in Civic Design or Town Planning is to be given at the University of Illinois by Charles Mulford Robinson, of Rochester, N. Y., who has recently been appointed to a professorship of civic design or town planning in that institution. The first semester, with 26 lecture hours, will be devoted to town remodeling, and the second, with 42 lecture hours, to town planning. Besides lectures, the students will take "field trips" and prepare theses. Besides the course just outlined there is a second one, on advanced landscape design, given in part by Prof. Robinson, and consisting of lectures, drafting-room work, reading and field trips. Prof. Robinson has made town-planning reports for many cities, and is author of a number of books, including "Modern Civic Art" and "The Width and Arrangement of City Streets."

An Anglo-American Exposition, celebrating the 100 years of peace between English-speaking peoples since the Treaty of Ghent in 1814, and progress in the arts, sciences, and industries of Great Britain and the United States, will be held in London, at Shepherds' Bush, the site of many previous expositions, from May to October, 1914. America is allotted seven vice-presidents, among whom are Jas. B. Forgan, Chicago, Ill.; Hon. D. R. Francis, St. Louis, Mo., and Alba B. Johnson, President of the Baldwin Locomotive Works, Philadelphia, Penn. The executive committee of the exposition includes Sir Archibald Geikie and Sir Edward J. Poynter, Bart., while on the American executive committee are Robert Dollar, of San Francisco, Calif., Ferdinand A. Roebling, of Trenton, N. J., and Wm. H. Stevenson, of Pittsburgh, Penn.

German Cement Prices—In recent competitive bidding on a contract for about 8000 tons of cement, to be awarded by the Hannover division of the State railways of Prussia, a low price of M. 18 per 1000 kg. was obtained ($0.74 per bbl.). This is 2 marks below the lowest price realized in a large bidding of a year ago. "Armierter Beton" of October, 1913, gives these figures, together with some other prices.

A Baseball Stand Collapsed at Tulsa, Okla., on Oct. 28, carrying with it 700 persons. One man was killed and 100 were injured. According to press dispatches, the seating capacity of the stand was 400.

The Grenchenberg Tunnel, Switzerland, which for two months has been idle due to strike of the tunnel laborers, has reached a total heading length of about 14,700 ft., of which 8500 is in the north end and 6200 in the south end. Work was resumed late in September at both ends. The tunnel has encountered heavy water flows and bad ground, but, nevertheless, has made good progress.

A New Dry Dock for New York harbor is contemplated, according to a statement made to the press on Nov. 2, by R. A. C. Smith, the Commissioner of Docks of the City of New York. The Commissioner said that the Department of Docks now has under study a very large dry dock to be located in the South Brooklyn district. The dimensions and design of the dock have not yet been decided upon, but it is announced that it is to be similar to the Gladstone dock at Liverpool, in that it is to be used as a berthing dock when not in use as a dry dock.

The Construction of the Second Simplon Tunnel is progressing rapidly. As the bottom heading was entirely completed (and lined where necessary) at the time the first tunnel was built, the enlargement can be attacked at a number of points, as may be convenient. The progress for September, 1913, included 1830 ft. of top heading, 1790 ft. of full-section excavation and 1840 ft. of arch construction. At the present time the completed length of full-size tunnel at both ends is 7700 ft., about two-thirds of this being at the north end. The completed length is a little less than one-eighth the final length of the tunnel. Sand-lime blocks are being used for arch construction in parts of the tunnel.

Results of Examinations for Railway Valuation Engineer—We are informed by our Washington correspondent that a total of 854 passed the examination for Senior Civil Engineer, for which position there were 3024 applicants. The salaries of this position are $3000 to $4000 per annum for Grade 1 and $1800 to $2700 per annum for Grade 2. The results of the examination are being communicated informally to the Interstate Commerce Commission, which, with the help of the Civil Service Commission, will soon commence a personal investigation of the records of every successful candidate. When this is done the names will be formally certified to the Interstate Commerce Commission. From the list of names of those certified, the Interstate Commerce Commission will make its appointments, probably not earlier than a month from now. The law provides that no more than one of three certified eligibles need necessarily be appointed.

A City-Planning Exhibition will be held in New York City the last week of November and the first week in December, 1913. The city-planning exhibition is being arranged in behalf of the Merchants Association of New York and the Heights of Buildings Committee appointed some time ago by the Board of Estimate and Apportionment. George McAneny, President of the Borough of Manhattan, is chairman of the Committee. George B. Ford is secretary of the Advisory Commission on City Planning with offices at 115 Broadway, New York City. The last named commission has placed the work of collecting and installing the exhibits in charge of the American City Bureau, 93 Nassau St., New York City. The city-planning exhibits will be selected from American and foreign city-planning practice, and will be in conjunction with an exhibition of the work done by the Heights of Buildings Commission, New York City.

A 110-Ton Electric Locomotive has supplanted the 100-ton type as the latest design of the New York Central & Hudson River R.R. for its New York City electric zone. The features of the 100-ton, 4-4-4-4 design (described in "Engineering News," May 1, 1913) have been preserved, except that a few motor details have been changed to secure greater continuous capacity. This has been done as the weight of trains out of Grand Central Station is steadily increasing. The 100-ton locomotive could safely develop 1460 hp. continuously, 2000 hp. for one hour and 5000 hp. for short periods. Tractive efforts were secured of 9000 lb. at 60 mi. per hr. continuously and 13,500 lb. at 54 mi. per hr. for one hour. The new locomotive (of which six have been ordered already) will develop 2000 hp. continuously or 2600 hp. for one hour with equivalent tractive efforts of 14,000 lb. at 54 mi. per hr. continuously, and 20,000 lb. at 49 mi. per hr. for one hour. The machines are being built by the General Electric Co., Schenectady, N. Y.

The Advance of Structural Methods in New York City is illustrated by the decision of the Standard Oil Co. to demolish the ten-story Tower Building, situated at 50 Broadway, New York City. At the time of its erection in 1889 it

was the tallest building in lower New York; and it was the first structure of the skeleton-steel type in the city. In the corridor is a tablet placed there in 1899 by the Society of Architectural Iron Manufacturers of New York commemorating its erection as "the earliest example of the skeleton construction in which the entire weight of the walls and floors is borne and transmitted to the foundation by a framework of metallic posts and beams." On the tablet, which will be preserved, are the names of the architect, Bradford Lee Gilbert, and of the Jackson Architectural Iron Works, which supplied the structural steel. In addition to the Tower Building, which has a frontage of 81.9 on Broadway by 72.9 ft. on New St. by 175 ft. on the southerly line, the two smaller buildings adjoining, at 44 and 48 Broadway, also owned by the Standard Oil Co., will be torn down as they have become unprofitable.

The Hudson River Flood at the end of March last, produced a maximum flow of 219,000 cu.ft. per second in the Hudson River at Albany, N. Y., according to the report of Col. Wm. M. Black, Corps of Engineers, U. S. A., recently presented to the Chief of Engineers:

An unprecedented flood occurred in the Hudson River, at the end of March, due to heavy rains, as the mildness of the winter had by that time melted practically all of the snow in the Adirondacks. The maximum height at Albany was reached shortly after noon Mar. 28, of 23½ ft. above lowest low water. Previous high records at Albany gave 23½ ft. in February, 1857 (due to an ice gorge); 21 ft. October, 1869 and 18.7 ft. in October, 1903, above lowest low water. The height reached in March, 1913, about a quarter of a mile above the state dam at Troy was 31.7 ft. and just below the dam 31.4. (The flood of 1857 reached about 26 ft. at Troy.) The depth over the crest was nearly 17 ft.

The maximum surface velocity observed between Troy and Albany was 8 miles per hour and at Albany about 6 miles per hour. The combined discharge of the Hudson and Mohawk Rivers (their junction occurs just above Troy) was estimated at 219,000 cu.ft. per second. The discharges in both streams exceeded former records, the flood in the Mohawk at Cohoes being estimated at 99,000 sec.-ft. and in the Hudson at Mechanicsville about 120,000 sec.-ft. The maximum previously recorded in the Hudson at Mechanicsville was 70,000 sec.-ft. in 1869.

Progress on New York Subway Construction to date may be summarized as follows:

The total amount of money to be expended by the city of New York in the construction of additions to the rapid transit system is estimated at $200,000,000. Of this amount about $83,000,000 worth of work is already under contract, and it is expected that $65,000,000 worth additional will be ready to let by the close of the year; so that by Jan. 1, 1914, nine months after the signing of the Dual System agreements, three-fourths of the city's part of the work should be under way.

When the agreements with the Interborough Rapid Transit Co. and New York Municipal Ry. Corporation were signed last March, the Public Utilities Commission began scouring the city for additional draftsmen and engineers. The engineering force at that time numbered about 800 persons, but the chief engineer decided he would have to get much additional help if the plans for the new work were to be prepared and promptly advertised for bids. In a few months about 300 draftsmen and engineers were employed. When the dual system agreements were signed, not one section of the Seventh Ave. line, in Manhattan, was under way. Today th Commission has opened bids for one section, has advertised for bids for two additional sections, will soon advertise for two more, and next month will hold hearings on the forms of contract for the last two sections of that line. By the first of the year, therefore, the whole Seventh Ave. subway, from Times Square south to the Battery, should be under contract.

Plans for additional sections of the Broadway subway, in Manhattan, and for subway extensions in Brooklyn, The Bronx and Queens have also been completed. In the Borough of Queens every construction contract for all the new lines in that borough has been placed under contract, with the exception of the Steinway Tunnel from its present terminus to the Queensboro Bridge, and that is now being advertised for bids. In Brooklyn the New York Municipal Ry. Corporation has been authorized to contract for the reconstruction of the Sea Beach line, which will connect the Fourth Ave. subway with Coney Island, and work thereon has been started. The same company also has been authorized to contract for the building of the proposed line through 38th St., Brooklyn, to connect the Fourth Ave. subway with the proposed elevated railroads through New Utrecht Ave. and Gravesend Ave. to Coney Island. Work has also begun on this line. It is expected that this road, as well as the reconstruction of the Sea Beach line, will be finished within 18 months.

The Public Service Commission has about completed the plans for the elevated railroad through New Utrecht Ave., and will advertise for bids for its construction early this week. It also has the plans for the Gravesend Ave., or Culver line, well under way, and will advertise for bids for its construction within a short time. Plans are also approaching completion for the two new tunnels under the East River—one for operation by the Interborough Rapid Transit Co., and the other by the New York Municipal Ry. Corporation. These should be ready to advertise before the end of the year. Plans for the Eastern Parkway subway in Brooklyn and its connections are also well advanced. The first sections of the line, from the end of the existing subway, out Flatbush Ave. to Eastern Parkway, will be submitted to bidders within a short time.

In The Bronx three separate lines of feeders for the new subway system will soon be under construction, namely, the Pelham Bay Park branch, the Jerome Ave. branch and the White Plains Road branch. The plans for all these branches are nearly completed, and a large portion of the work will be put under contract next month.

PERSONALS

Mr. C. H. Kluegel, M. Am. Soc. C. E., recently Chief Engineer of the Hilo R.R., Honolulu, H. I., has been appointed Inspecting and Consulting Engineer of the Waiahole Water Co., Ltd., Island of Oahu.

Mr. W. G. Chase, M. Can. Soc. C. E., of the firm of Kerry & Chace, Ltd., Consulting Engineers, Toronto, Ont., has been appointed Chief Engineer for the construction of the Greater Winnipeg water-supply system.

Mr. E. E. McLellan, Chief Engineer, has been appointed General Superintendent of the San Benito & Rio Grande Valley R.R., at San Benito, Tex., succeeding Mr .E. S. Heyser, resigned as noted in our issue of last week.

Mr. James T. Newton, Principal Examiner, United States Patent Office, has been appointed Assistant Commissioner of Patents. Mr. Newton has had 22 years' continuous service in the Patent Office as Assistant Examiner, Law Clerk, Chief Clerk and Principal Examiner since 1895.

Dr. Charles P. Steinmetz, Past-President, Am. Inst. E. E., Consulting Engineer of the General Electric Co., was a candidate for Alderman of his home city of Schenectady, N. Y., on the Socialist ticket, at the election on Nov. 4. A full-page character sketch of Dr. Steinmetz was published in the New York Sunday "Times" of Nov. 2.

Mr. E. C. Smith, Ex-Governor of Vermont, and a lawyer of St. Albans, Vt., has been elected President of the Central Vermont Ry., succeeding Mr. E. J. Chamberlin, President of the Grand Trunk Ry., of which the Central Vermont is a subsidiary. Mr. Smith was President of the Central Vermont from 1891 to 1899. Mr. Chamberlin continues as chairman of the Board.

Dr. Hollis Godfrey, head of the department of science, School of Practical Arts, Boston, Mass., from 1907 to 1912, has been elected President of Drexel Institute, Philadelphia, Penn. Dr. Godfrey is a graduate of Tufts College, 1895, and of the Massachusetts Institute of Technology, 1898. In October, 1912, Dr. Godfrey was appointed Chief of the Bureau of Gas, Department of Public Works, Philadelphia, Penn.

Mr. Robert Quayle, recently Superintendent of Motive Power and Machinery of the Chicago & Northwestern Ry., has been promoted to be General Superintendent of the motive-power and car departments, with headquarters at Chicago, Ill. Mr. Quayle is an Englishman and entered the employ of the Chicago & Northwestern Ry. in 1871 as a machinist apprentice. He was made Superintendent of Motive Power in 1894.

Mr. H. T. Bentley, M. Am. Soc. M. E., recently Assistant Superintendent of Motive Power and Machinery of the Chicago & Northwestern Ry., has been promoted to be Superintendent of Motive Power and Machinery, succeeding Mr. Robert Quayle, promoted as noted elsewhere. Mr. Bentley is an Englishman and a graduate of Dulwich College; he entered the employ of the London & Northwestern Ry. in 1877, at 15 years of age, as a machinist apprentice. His first position with the Chicago & Northwestern Ry. was as machinist at the Chicago shops in 1892. In 1902 he was made Assistant Superintendent of Motive Power and Machinery.

Mr. Louis W. Hall, M. Am. Soc. C. E., recently Engineer, Pacific Power & Light Co., Portland, Ore., has opened an office at 401 American Trust Bldg., Birmingham, Ala., for the general practice of civil engineering. Mr. Hall has been connected with the United States Government service and the New York State Engineering Department for the past 15 years. For five years he was Junior Engineer and Assistant Engineer, War Department, on the design and construction

of locks and dams for the Warrior River system in Alabama; and for seven years he was Engineer with the U. S. Reclamation Service on the design and construction of irrigation works in the Pacific District. While with the New York State Engineering Department he was employed on the design of structures for the New York Barge Canal.

Mr. T. M. Schumacher, Vice-President of the El Paso & Southwestern System, of New York City, has been elected Chairman of the Board of the Chicago, Rock Island & Pacific Ry. and of the Rock Island Co. Mr. Schumacher was born in Pennsylvania in 1862 and began his railway experience at the age of 17 years as a telegraph operator on the Atlantic & Great Western R.R. He served with the traffic departments of various middle-western railways until 1890, when he was made General Agent of the Union Pacific Ry., at San Francisco, Calif. Four years later he became Vice-President and General Manager of the Continental Fruit Express, at Chicago, Ill. In 1900 he returned to his former position at San Francisco and in six months was promoted to be Traffic Manager of the Oregon Short Line R.R. From 1905 to 1906 he was Traffic Manager of the United Fruit Co., at New York City, and for three years succeeding was General Traffic Manager at Chicago for the railroads controlled by Phelps, Dodge & Co., of New York City. Mr. Schumacher was Vice-President of the Denver & Rio Grande R.R., and the Western Pacific R.R., at San Francisco, from 1909 to 1910, and for a short time in 1910 was Assistant Director of Traffic of the Harriman lines at Chicago. Later he was Traffic Manager of the American Smelting & Refining Co. and Vice-President of the Nevada Northern and Bingham & Garfield Rys., and since Nov. 1, 1912, Vice-President of the El Paso & Southwestern System.

Mr. B. B. Milner, M. Am. Soc. M. E., formerly Assistant Master Mechanic of the Philadelphia, Baltimore & Washington R.R., at Wilmington, Del., has been appointed Special Engineer on the staff of the Senior Vice-President of the New York Central Lines, at New York City. Mr. Milner's first railway experience was in the employ of the Missouri, Kansas & Texas Ry., as a machinist helper at the Parsons, Kan., shops. He left this work in 1900 to take a course in mechanical engineering at Purdue University, where he graduated in 1904. Following his graduation he entered the service of the Pennsylvania R.R. as a special apprentice at the Altoona shops. He was soon placed on special work and in the latter part of 1904 and in 1905 was engaged in investigating the relations between speed and load in freight-train performance. Later he had charge of a rearrangement of the machine-tool equipment at the Altoona shops. In 1908 he was sent on an extensive tour of the railway shops of the West to gather ideas for the betterment of methods and practices. Since then the major part of his time has been given to special work and problems of the Pennsylvania R.R. Mr. Milner had charge of the preparation of the railway company's side of the case to the arbitration board on the enginemen's demand for an increase of wages in 1912, and did similar work in connection with the firemen's demand in 1913. He has been Assistant Master Mechanic at Wilmington, since January of this year.

Mr. Clayton D. Mell, of the United States Forest Service, sailed from New York City on Oct. 16 for British Guiana, where he will have charge of inspecting greenheart timber to be used in the construction of docks and other marine work for the Panama Canal. He was sent at the request of the Isthmian Canal Commission in order to assure the government engineers at Panama that they were getting genuine greenheart timber, for which a number of inferior substitutes are offered. Mr. Mell will go first to the Isthmus and from thence to Demerara, British Guiana, the principal port for export of greenheart timber. He will be accompanied by an employee of the Canal organization and will see all the operations of lumbering in order that true greenheart may be selected and identified without possibility of error. He is given charge not only of inspection, but also of the preparation of specifications for buying the timber. Of this greenheart timber a recently issued news bulletin of the U. S. Department of Agriculture says:

Genuine greenheart has the reputation of being the most resistant wood to attack of marine borers and to decay. The wood is, in addition, hard, heavy and durable, and not subject to damage from impact and wear. Indisputable records show that the best grades of this wood surpass iron and steel as to lasting qualities in contact with salt water. It has been known and used since 1769. Logs have remained intact under water for 100 years. Lock gates in English canals have been made of it for years, and the only limit of their durability so far has been the length of service of the iron bolts and fastenings, which usually can be renewed without much trouble. Greenheart in Liverpool lock gates built in 1856, removed to allow a deepening and widening of the ship channel in 1894, was used over again when the gates were reconstructed. The sills and fenders of the lock gates at Panama are made of greenheart, and much of the wharf work will be constructed of the same material.

OBITUARY

John Cox Underwood, a graduate of Rensselaer Polytechnic Institute in 1862, died at the Hahnemann Hospital, New York City, Oct. 26, aged 73 years. He was the son of a Kentucky judge and immediately following his graduation he joined the Confederate Army, rising to the rank of Lieutenant-Colonel. After the war he was City Engineer of Bowling Green, Ky., County Engineer and Consulting State Engineer.

William Osbourne Sprigg, President of the General Contracting & Engineering Co., New York City, and former Superintendent of the New York division of the Lehigh Valley R.R., died Oct. 26, at his home in Tomkinsville, Borough of Richmond, New York City. He was born in Cumberland, Md., in 1865, and at 14 years of age joined the engineering corps of the George's Creek & Cumberland Valley R.R. as rodman. Later he was Assistant Engineer of the Baltimore & Cumberland Valley R.R., now a part of the Western Maryland Ry., and Assistant Engineer and subsequently Engineer of Construction of the Pittsburgh & Western R.R. In the latter part of 1882 he was appointed Roadmaster of the Baltimore & Ohio R.R., and three years later was promoted to be Engineer of Maintenance-of-way of the New York extension. For eight years, 1886 to 1894, he was Master of Transportation and Superintendent of the Staten Island Rapid Transit R.R. For a short time he was Superintendent of the Southern Ry. and from 1898 to 1904 was Superintendent of the New York division of the Lehigh Valley R.R.

ENGINEERING SOCIETIES

COMING MEETINGS

GREAT LAKES INTERNATIONAL PURE WATER ASSOCIATION.
Meeting postponed until further notice. Secy., Paul Hansen, Urbana, Ill.

UNITED STATES GOOD ROADS ASSOCIATION.
Nov. 10-16. Third annual meeting at St. Louis, Mo. Secy., J. M. Rountree, Birmingham, Ala.

NATIONAL CONSERVATION CONGRESS.
Nov. 18-20. Annual meeting at Washington, D. C. Secy., T. R. Shipp, Indianapolis, Ind.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
Dec. 2-5. Annual meeting in New York. Secy., Calvin W. Rice, 29 W. 39th St., New York City.

AMERICAN SOCIETY OF REFRIGERATING ENGINEERS.
Dec. 1-2. Annual meeting in New York. Secy., W. H. Reed, 154 Nassau St., New York City.

ASSOCIATION OF AMERICAN PORTLAND CEMENT MANUFACTURERS.
Dec. 8-11. Annual meeting in New York. Secy., Percy H. Wilson, Land Title Bldg., Philadelphia, Penn.

SAND-LIME BRICK ASSOCIATION.
Dec. 9-10. Annual meeting at Harrisburg, Penn. Secy., W. E. Plummer, Jr., 211 Fillmore Ave., Buffalo, N. Y.

AMERICAN ROAD BUILDERS' ASSOCIATION.
Dec. 9-12. Annual convention at Philadelphia, Penn. Secy., W. H. Tolman, 29 W. 39th St., New York City.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS.
Dec. 10-13. Annual meeting in New York. Secy., J. C. Olsen, Polytechnic Institute, Brooklyn, N. Y.

SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS.
Dec. 11-12. General meeting in New York. Secy., D. H. Cox, 29 W. 39th St., New York City.

Kansas Engineering Society—The annual meeting of the society will be held at the University of Kansas, on Jan. 20-21, 1914.

Cornell Society of Civil Engineers—At the annual meeting of the society, which now has nearly 700 members, at the Cornell Club, New York City, W. D. Kelley ('81) was elected president, and E. A. Truran ('95), corresponding secretary and treasurer, for the ensuing year.

Canadian Institution of Municipal Engineers—The following have been appointed to act on the provisional committee to draft the constitution of the proposed Canadian Institution of Municipal Engineers: J. Antonisen, Street Railway Superintendent, Brandon, Man.; M. H. Baker, City Engineer, Prince Albert, N. W. Ter.; Willis Chipman, Consulting Engineer, Toronto, Ont.; G. T. Clark, City Engineer, Saskatoon, Sask.; G. W. Craig, City Engineer, Calgary, Alta.; Archibald Currie, City Engineer, Ottawa, Que.; F. L. Fellows, Supervising City Engineer, Vancouver, B. C.; G. D. Mackie, Town Engineer, Swift Current, B. C.; T. A. Murray, Consulting Engineer, Toronto, Ont.; F. McArthur, City Engineer, Regina, Sask.; H. H. Phillips, Toronto, Ont.; R. Potter, Town Engineer, Battleford, Sask.; J. B. Sterling, City Engineer, North Battleford, Sask.; L. A. Thornton, City Works Commissioner, Regina, Sask.; R. O. Wynne-Roberts (Convenor), Consulting Engineer, Regina, Sask.